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PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

AUGUST 1953

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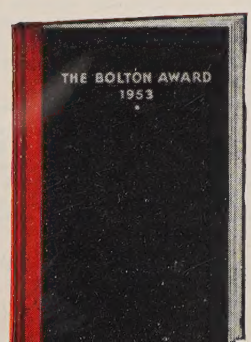

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		13. Suspension

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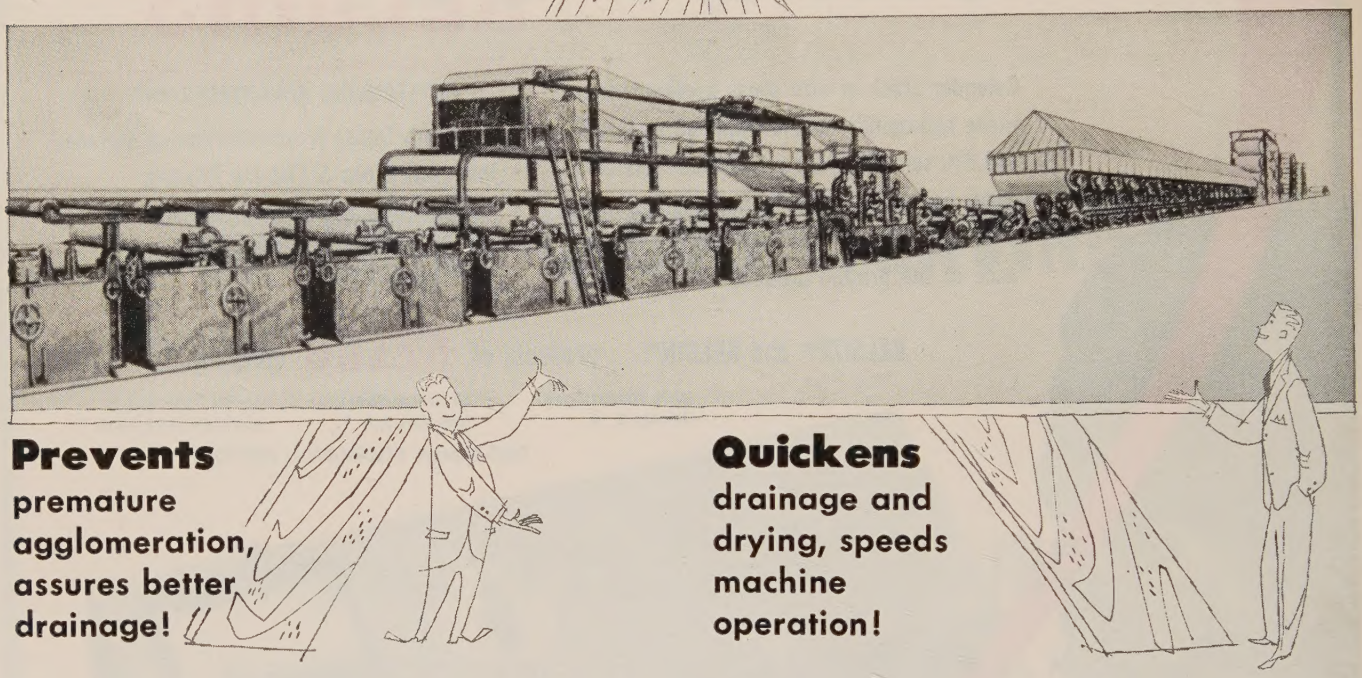

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FOR THE PAPER INDUSTRY

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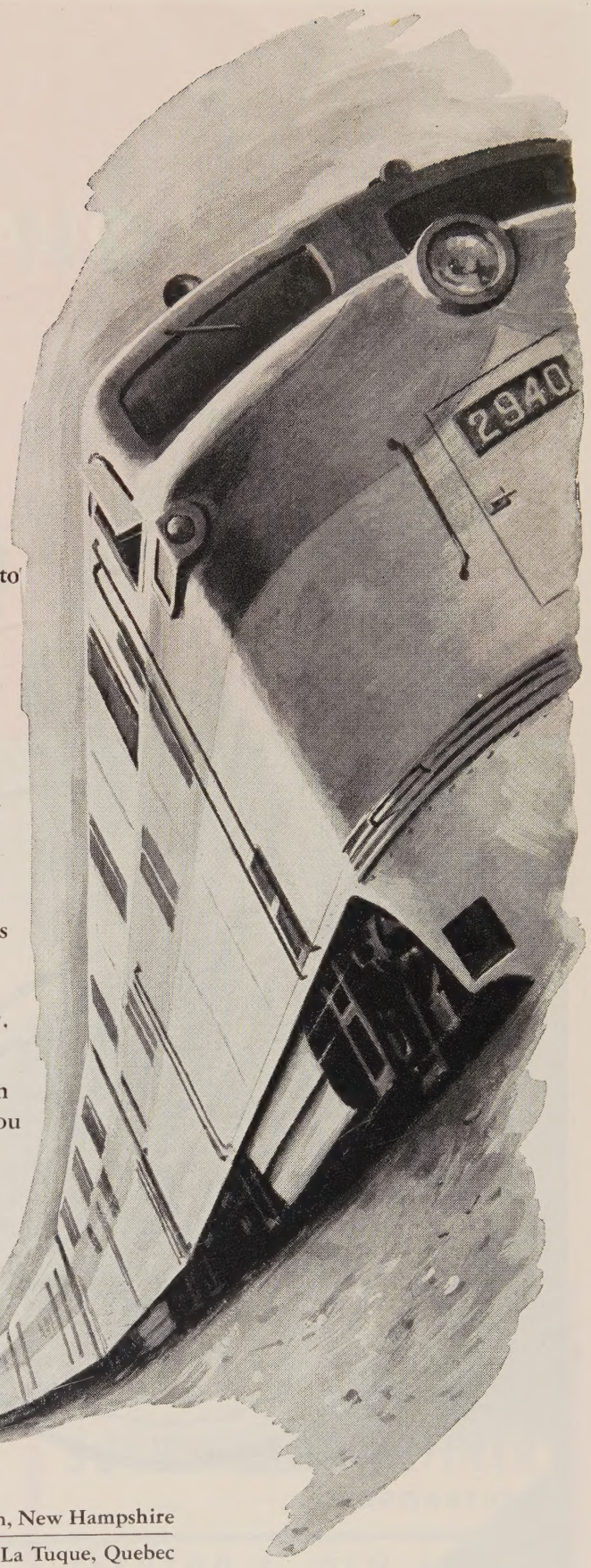

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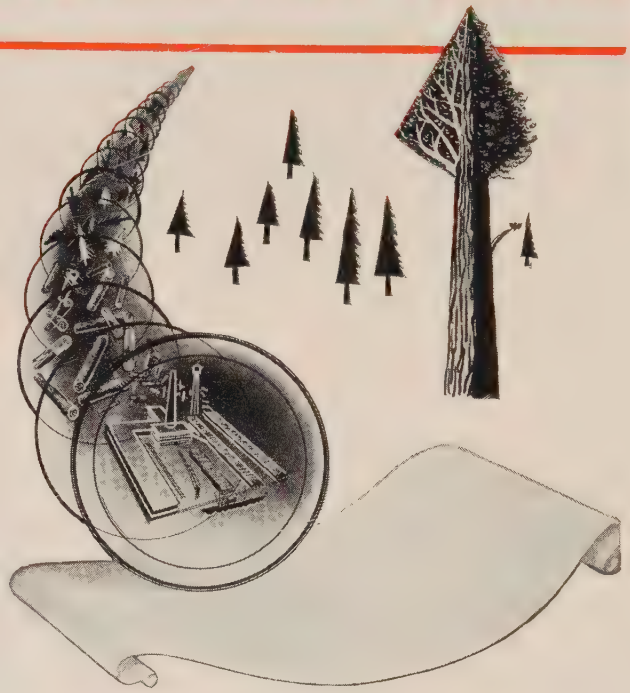

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RESULTS

Mills using this process have reported a 15 to 20% increase in yield over normal operation, and substantial reduction in operating costs as a result of savings in wood. In addition to substantially increased profits, the new process marks a major step forward in wood conservation.

APPLICATIONS

The Sutherland High Yield Process is being used for the production of high yield linerboard and will, in the near future, be applied to other unbleached grades. Bleaching of high yield pulps is a possibility and does result in a marked increase in yield, although at the present cost of wood and chemicals, it does not offer the savings possible in unbleached grades. The use of this system for bleached pulps will follow a natural development course in the foreseeable future.

PATENT

U. S. Patent No. 2,591,106, dated April 1, 1952, has been issued covering this process. While this patent in no way limits the user of the process in his choice of equipment, it does limit the use of the process to licensees of the Sutherland Refiner Corporation. Licenses are available to qualified mills on application to Sutherland Refiner Corporation.

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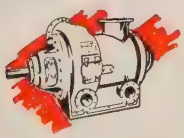

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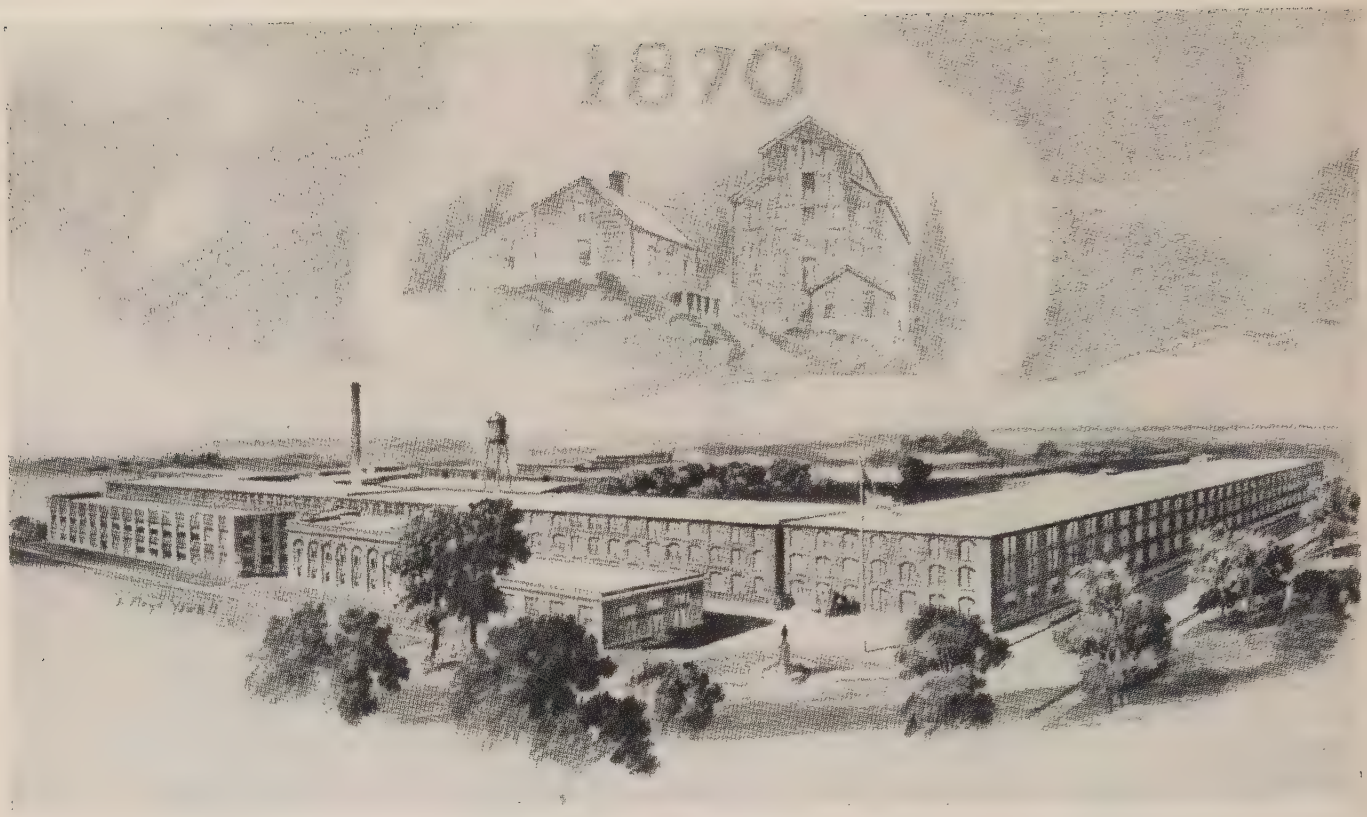

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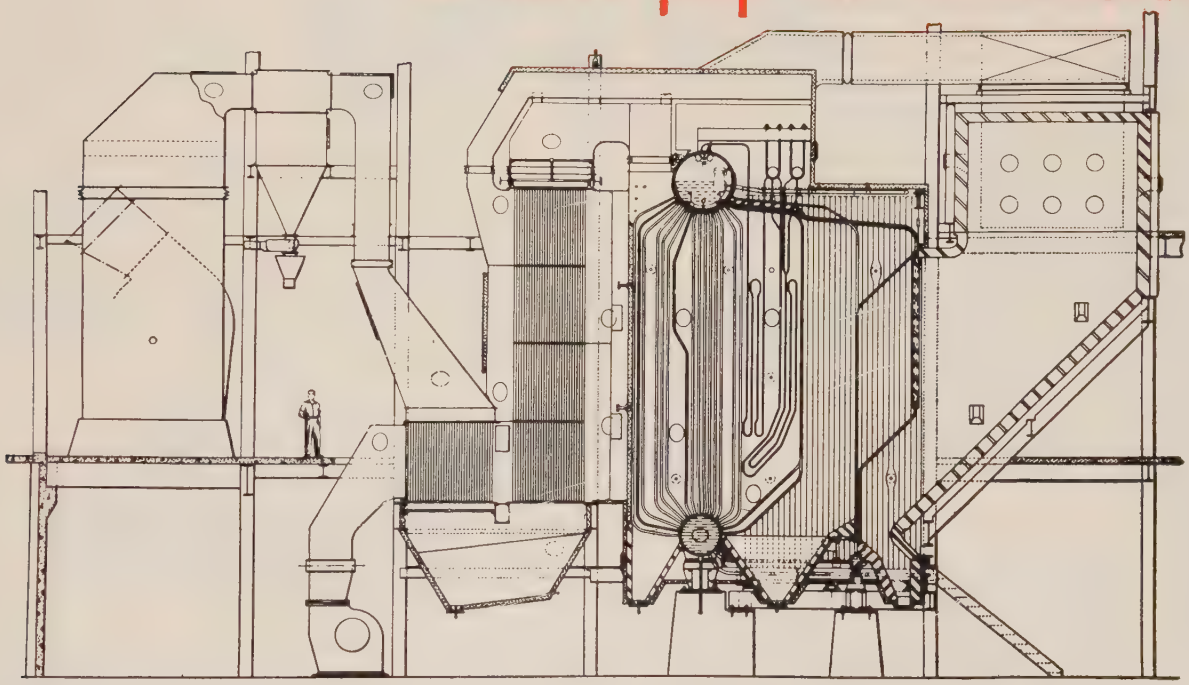

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P-779

THE UNITED STATES PAPER INDUSTRY—A REVIEW AND FORECAST

LOUIS T. STEVENSON

FOREWORD

As the sixth largest industry in the United States and one in which great changes are taking place, it seems to us that the paper industry deserves more careful analytical attention on the part of institutional investors than it is generally receiving.

This study by Dr. Stevenson, now associated with us and for the past 10 years economist for the American Paper & Pulp Association, is intended to bring out the present situation of the industry and to suggest some of the problems which the investor ought to consider in connection with his choice of holdings. We expect it will be followed periodically by other studies in which Dr. Stevenson will discuss such changes as may have occurred in the over-all picture and, from time to time, the situation and outlook for individual companies in the group.

This particular study is divided into three parts:

Part I—indicates (a) growth patterns of major segments of the industry and of the industry as a whole and (b) the relative stability of earnings in the industry.

The lists of companies in Part I (a) are illustrative only. The companies mentioned, while important in the fields indicated, do not cover the entire activity in these grades. There are many other qualified suppliers.

Part II—deals with the economic characteristics including past and current price behavior.

Part III—includes short and long-term forecasts of production trends. ***—Tucker, Anthony & Co.***

GROWTH AND STABILITY

A Growth Industry

THE paper industry has been a growth industry. It continues to be a growth industry and probably will continue so for a long time. The growth patterns of the various segments of the industry and the industry as a whole are shown in Figs. 1 and 2. These patterns are impressive and reveal an industry with a robust growth when compared with any industry of an equal age.

The United States paper industry was founded in 1690 and is much older than some of the other industries. It is recognized that in its early development an industry can be expected to have a high percentage rate of growth which then tapers off as the industry ages. The so-called "mature" paper industry may be considered quite robust, in view of the fact that in this country it is as old as any and much older than some and still maintains a very high annual rate of growth.

The annual growth rates of consumption for the segments of the paper industry as developed by the National Industrial Conference Board based on the long-term trend but taken as of the year 1950 are here tabulated:

	Annual rates of growth, %
Construction paper and construction board	8.19
Tissue and sanitary papers	5.29
Coarse papers	4.24
Paperboard	4.04
Fine papers	3.23
Groundwood and book papers (printing papers)	2.97
Newsprint	1.23
Industry-wide average (including newsprint)	3.47
Industry-wide average (excluding newsprint)	4.66

The United States newsprint supply comes mainly (82%) from abroad and consequently the growth factor for the consumption of United States paper production should exclude newsprint. On that basis, the average annual rate of growth would be 4.66%. This and the above rates of growth for the segments compare quite favorably with the percentage rates of growth for the following industries:

Commodity	*Annual rates of growth, %*
Natural gas—produced and delivered	5.06
Aluminum production	4.54
Electric energy produced	2.99
Deflated gross national product	2.94
Chemical mineral production	2.93
Fuel production	2.36

This last table covers fast-growing commodity groups in the Conference Board study. Among the slower groups will be found such well-known series as steel ingot production—1.04% and portland cement production—0.166%.

An interesting approach to the subject of growth rates is to consider the growth rate of the deflated gross national product as the rate of growth of the whole economy. From this base, a higher rate would indicate faster growth than the economy as a whole. A lower rate would indicate that the economy as a whole was "running away" from the commodity. Such a commodity might be increasing in absolute terms yet losing ground with respect to the economy taken as a whole.

Charts I and II cover apparent per capita consumption of the major grades of paper and board. The semilogarithmic basis used in the charts indicates comparative rates of growth. Parallel slopes have the same rate of growth and horizontal movements show no rate of growth. In using per capita consumption

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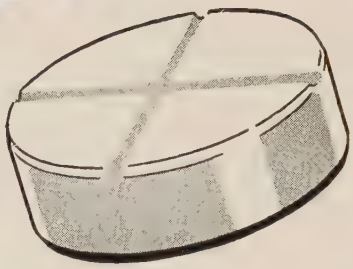

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the growth of population is eliminated from the figure but should be taken into account as an additional stimulating factor when considering the actual tonnage consumption of these products.

An outstanding feature of these charts is the upward growth of all segments of the industry. Some move at a faster rate than others and some move more erratically than others, but they all move up.

Newsprint (Chart I). Newsprint consumption per capita which grew so rapidly in the 1920's has since tapered off in its rate of increase. Its increase apparently will mainly depend upon population growth from here on.

Companies making newsprint in the United States include Coosa River Newsprint Co., operated by Kimberly-Clark Corp., Crown Zellerbach Corp., Great Northern Paper Co., and Southland Paper Mills, Inc.

International Paper Co., Kimberly-Clark Corp., Minnesota & Ontario Paper Co., and Crown Zellerbach Corp. are in Canadian newsprint through interest in subsidiaries.

Tissue (Chart I). Tissue influenced by the sharp upward growth of the sanitary papers included in this category shows, next to construction papers and construction boards, the sharpest upward slant of all. Also, its depression record in the 1930's is outstanding, with per capita consumption holding steady. The war years were down slightly but that was due to war conditions from which the industry recovered rapidly after 1945. The drop in 1952 was common to most grades as well as to most industries and the upward growth should continue well into the future.

Important producers of sanitary papers are: APW Products Co., Inc.; Brown Co.; Crown Zellerbach Corp.; Hoberg Paper Mills, Inc.; Hudson Pulp & Paper Corp.; Kimberly-Clark Corp.; Marathon Corp., and Scott Paper Co.

Paperboard (Chart II). Paperboard consumption shows a high annual growth rate. Paperboard consumption is more cyclical than tissue but less cyclical than construction paper and construction board. These latter have shown spectacular growths since the depression low of 1933. Their movements, historically speaking, have been erratic compared with other segments of the industry and also with the business cycle.

Paperboard is a large group and includes subsections of food board, container board, and boxboard. The tonnage of the food board group has been growing quite rapidly. Among the prominent producers are: Champion Paper and Fiber Co., International Paper Co. Marathon Corp., Sutherland Paper Co., and West Virginia Pulp & Paper Co.

Some of the above group make container board in addition to food board. These include: International Paper Co., and West Virginia Pulp & Paper Co.

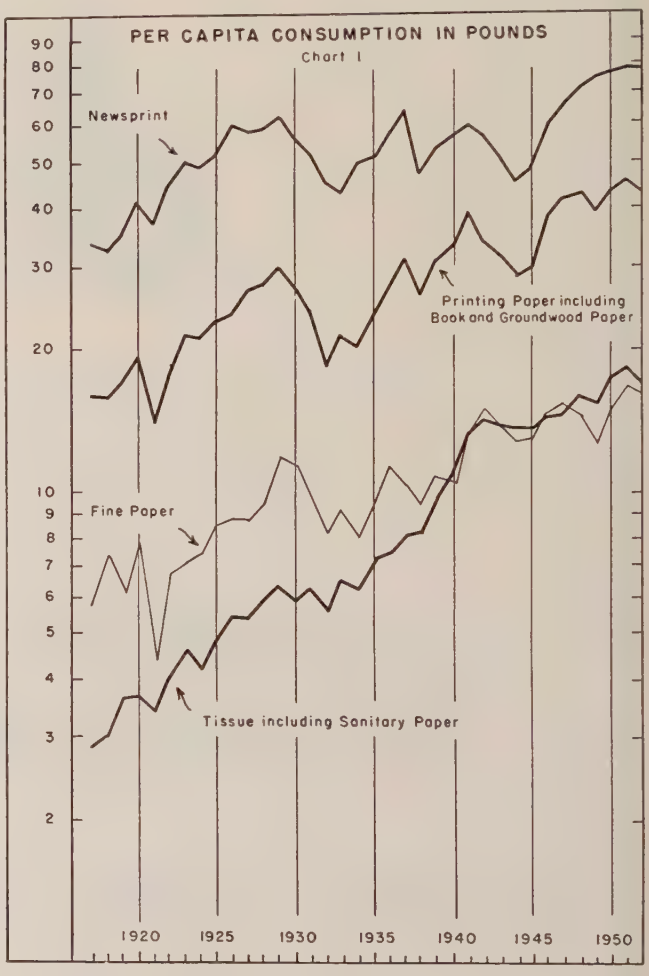
Companies that make sizable volumes of container board and relatively little food boards are: Container Corp. of America, Gaylord Container Corp., Hinde & Dauche Paper Co. National Container Corp., Mead Corp., and Union Bag & Paper Corp.

The following companies are among the important producers of boxboard: Container Corp. of America, Fiberboard Products Co., and Robert Gair Co., Inc.,

Printing and Fine Papers. The printing and fine paper groups (Chart I), while occupying different levels, move almost parallel and the movements up and down are almost simultaneous, indicating that these groups respond in the main to practically the same market influences.

The printing paper groups include book and groundwood paper manufacturers and fine papers include such items as writing, bond, ledger, index bristol, and a number of high-grade specialties.

Prominent in the book paper field are: Champion Paper & Fiber Co., Consolidated Water Power & Paper Co., Crown Zellerbach Corp., P. H. Glatfelter Co., International Paper Co., Kimberly-Clark Corp., Mead Corp., Oxford Paper Co., S. D. Warren Co., and West Virginia Pulp & Paper Co.



In the groundwood paper group are included: Crown Zellerbach Corp., Great Northern Paper Co., International Paper Co., Mead Corp., and St. Regis Paper Co.

Many of the mills making book paper also make some of the fine paper grades, as it is possible to switch from one to the other without major changes in the manufacturing processes. Among the companies in the fine paper industry are: American Writing Paper Corp., Champion Paper & Fiber Co., Eastern Corp., Hammermill Paper Co., International Paper Co., Mead Corp., Nekoosa-Edwards Paper Co., S. D. Warren Co., and West Virginia Pulp & Paper Co.

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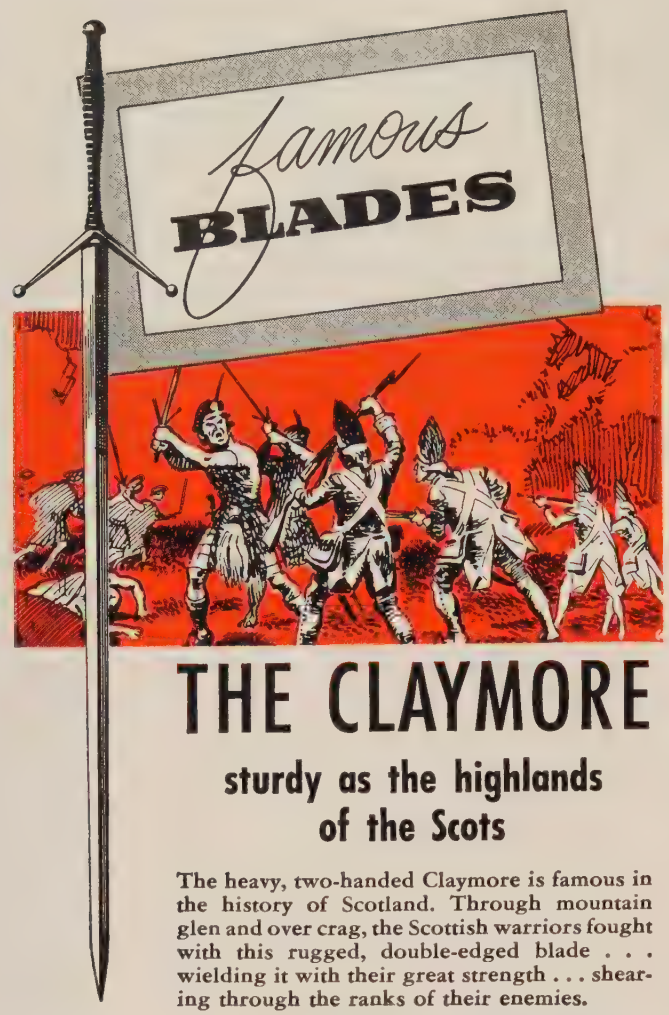

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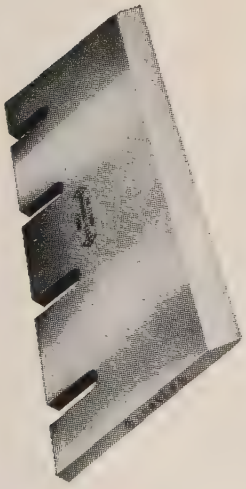

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Coarse Papers (Chart II). Coarse papers include kraft papers, sulphite wrappings, and glassine, greaseproof and vegetable parchment.

Some of the grades grow faster than others but the net effect on the group total is shown on the chart as "coarse paper." This line is steadier, that is, shows less fluctuation, than the printing paper line.

In the fast-growing food wrapping paper group will be found: Champion Paper & Fiber Co., International Paper Co., Kalamazoo Vegetable Parchment Co., Marathon Corp., Nekoosa-Edwards Paper Co., Rhinelander Paper Co., Riegel Paper Corp., and West Virginia Pulp & Paper Co.

In the more general coarse paper field are: Crown Zellerbach Corp., Gaylord Container Corp., International Paper Co., St. Regis Paper Co., Union Bag & Paper Corp., and West Virginia Pulp & Paper Co.

Construction Paper and Construction Boards (Chart II). This group has the fastest annual rate of growth (8.19%) and at the same time, the most erratic behavior of any of the groups. Heavily tied in with the construction of new residences, it shows a severe slump during the depressed 1930's and a boom development in recent years.

Major companies in this field are: Armstrong Cork Co., Flintkote Co., Johns-Manville Corp., Ruberoid Co., and U. S. Gypsum Co.

Diversification

It will be noted that a number of larger companies operate in several of the above segments. The list includes such companies as: Champion Paper & Fibre Co., Crown Zellerbach Corp., Gaylord Container Corp., International Paper Co., Kimberly-Clark Corp., Mead Corp., St. Regis Paper Co., Union Bag & Paper Corp., and West Virginia Pulp & Paper Co.

Newsprint consumption is the only segment of the paper industry with a growth rate (1.23% annually) below that of the deflated gross national product—(2.94%). Foreign sources now furnish 82% of United States newsprint consumption (79% from Canada and 3% from Europe) and newsprint production is an important item in the earnings of but three of these companies, namely, International Paper Co., Crown Zellerbach Corp., and Kimberly-Clark Corp. In none of these is newsprint a dominant factor in the earnings picture as all three companies are widely diversified. Furthermore, their newsprint operations are low cost. It is, therefore, clear that an investment in the United States paper industry is preponderantly an investment in an industry that is growing faster than the United States gross national product. With these large companies, diversification among the major paper grades assures them of a high average annual rate of growth, plus the advantages due to diversification.

The Over-all Industry (Chart II)

The net result of all these movements is shown in the total paper and board line. This shows a well-defined upward trend of use from 108.8 lb. per capita in 1914 to a high of close to 400 lb. per capita in 1951. The upward growth and close correlation with broad general movements in business have been characteristic of the industry. The highs and lows of the paper curve coincide almost exactly with the

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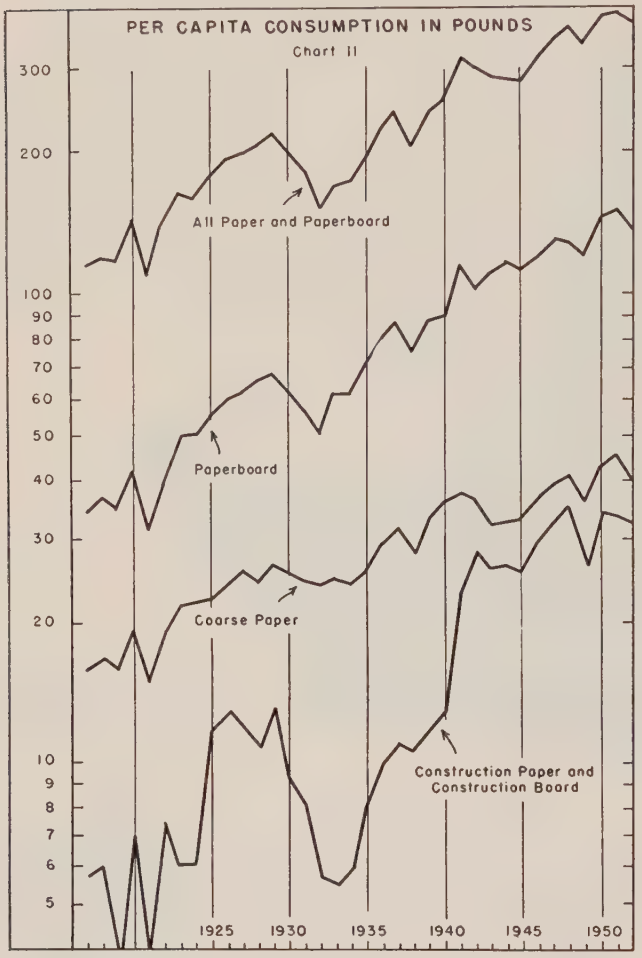
highs and lows of the business cycle as defined by Burns and Michell.* But the upward growth of the paper curve is such that the low point of its cycle is almost invariably above the high of the preceding cycle. There are good indications that the year 1952 showed such a low and it seems clear, judging by past experience, that the next high will be well above the 1951 high of 26 million tons production and 30.7 million tons of apparent consumption.



How have these patterns developed? They have been the result of:

1. A growing population.
2. A growing use of paper by the individual and business.
3. The expanding raw material base on which the industry depends for its sustenance.
4. Development of new products and applications through both fundamental and market research.
5. Energetic exploitation and marketing of the products of the industry.

Many are familiar with the tremendous increases in the use of paper by individuals, companies, government, etc., and population growth is not news to them.

But the growth in the raw material base has been and is continuing to be a major technical accomplishment.

* "Measuring Business Cycles," National Bureau of Economic Research, New York, 1946.

Papermaking depended for raw material upon rags until the middle of the nineteenth century when the raw material base was broadened by the introduction first, of groundwood pulp and later the chemical pulps, sulphite and sulphate.

The growing demand for paper, which was fed in part by the spread of education through the use of paper, encouraged the development of the techniques for using different wood species.

First, spruce was the favored wood and it was thought that the volume of spruce stands would limit the volume of paper production. Then a whole series of technical developments brought into use other woods, until now over 26 million cords of wood of a number of species are consumed annually and the end is not yet in sight. The semichemical pulping process for hardwood is opening up a new and almost untouched source of raw material. So far as it is at present discernible, wood supplies in this country are going to be adequate, if properly handled, for a vast increase in paper and board production. The question is an economic and technical one and not one of absolute physical limitations because timber is a crop that can be and is being grown.

A Stable Employment Industry

Important in any consideration of the labor factor is that employment in the industry is exceptionally steady. A recent study of seasonal fluctuations in employment in industry by the Federal Reserve Board shows the paper and pulp industry to have an almost unexcelled record for steadiness of employment. The low of the index of seasonal variation in employment is in July at 98% and the total seasonal change in employment is but 3%.

Production is relatively stable in both booms and depressions (see Figs. 1 and 2). In 1932 compared with 19½%* for the steel industry, the paper industry operated at 58% of capacity.† Production in all industry dropped 47% from 1929 to the bottom of the depression in 1932 while the paper industry dropped only 24% in the same period.‡ In the same period, employment lost 36% in all manufacturing as compared with a decline of only 20% in the paper and allied products industry.§

Stability of Earnings

In a recent comparison of the rate of return after taxes on stockholders' investment for 512 identical corporations in 25 selected industries, the paper and allied products industry was in the top half in every year. The study, by the Federal Trade Commission and the Securities and Exchange Commission, covered the years 1940 and 1947 through 1950.

Earnings during the depression 1930's also compared favorably with earnings of manufacturing industry in general (Chart III).¶

In 1952, a year of recession in the paper and board industry and of lower profits in manufacturing indus-

* Survey of Current Business.
† Source: American Paper and Pulp Association.
‡ Federal Reserve Board.
§ Source: Bureau of Labor Statistics.
¶ See "Statistics of Income, U. S. Treasury" and "National City Bank-Monthly Letter."

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tries generally, the paper and allied products' earnings were a shade better than all manufacturing.

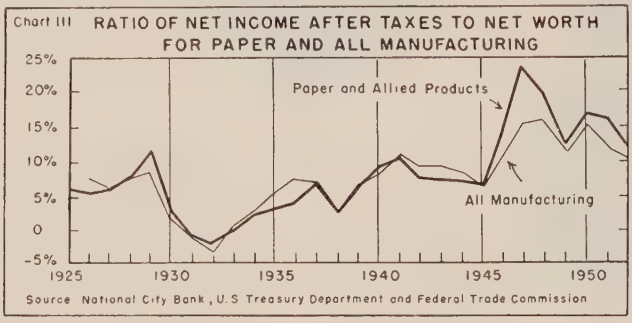
The comparative figures follow for net earnings after taxes:†

As	Paper	All Manufacturing
Per cent of sales	5.7	4.3
Per cent of net worth	10.3	10.2

Clearly, earnings in the paper industry were better than average at the bottom of the depression in 1932 and have, since 1925, never been lower than average for all manufacturing in any recession.

ECONOMIC CHARACTERISTICS OF THE INDUSTRY

The paper industry is a natural resource industry dependent upon wood pulp for over 60% of its raw material, wastepaper for over 30%, straw for 2¼%, and rags and other fibers for about 4%.



The industry is resourceful depending for much of its raw material on what has been previously discarded as waste. This is true of wastepaper, rags, straw, and many of the "other fibrous materials." It is also true of much of the pulpwood including that which comes from thinnings, tops, sawmill slabs, and a number of hardwood species that otherwise would have very little use.

This aspect of the paper industry becomes more and more important as the industry grows and the nation's natural resource of wood supply attains a higher degree of utilization.

Some recent developments emphasize the economics of this aspect. Among them are:

1. The use of sawmill slabs and waste as chips for pulpwood.
2. Sale of stumpage by pulp mills to lumber manufacturers.
3. The production of saw timber by pulp manufacturers from their own timber stands.
4. The practice by pulp mills of using thinnings from their own forests and saving the larger trees for sawlogs.
5. The use of hardwood for pulping purposes.

With an annual consumption of over 26,500,000 cords in the pulping processes (25,000,000 cords of it domestic wood), it is felt by many that the industry may be "running out of wood" in the discernible future. This should be considered in context with other uses and the available supplies.

The 1944–45 Forest Survey is the latest official comprehensive survey of United States forest resources.* The growth and drain figures for 1944 are shown in the following table.

	Millions cu. ft. Growth	Drain	Margin
Softwood	6,756	8,151	−1395
Hardwood	6,614	5,510	+1104
Total	13,370	13,661	− 291

The drain was allocated to:

Lumber	49.1%
Firewood	16.1%
Pulpwood	9.6%
Miscellaneous	14.4%
Losses by fire	3.4%
Losses by insects/disease	7.4%
Total	100.0%

Regional data show that in most regions over-all growth and drain were not far out of balance. The Pacific Northwest, with most of its forest resources in virgin stands of softwood, however, shows a considerable excess of drain over growth (about 1350 millions of cu. ft.). This is a natural result from the utilization of the stands and does not necessarily indicate a current disregard for sustained yield practices. With mature timber, which it is necessary to harvest before reproduction can be started, there will be a considerable period in which drain will exceed growth because mature stands have a minimum net growth and carry large volumes of standing timber. It will be necessary to cut the mature timber before sustained yield practices can be started.

This in broad outline is the background for the paper industry's wood supply.

It is clear from these data that the "shortage" in softwood is due largely to lumber operations which dominate the softwood consumption. The pulpwood volume has been increasing since 1944 and lumber volume declining.

There are many and complex interrelated factors in these relationships that are difficult to evaluate and this is not the place to do it. Suffice it to say that the pulp and paper industry is turning to the abundant supply of hardwood and is practicing advanced scientific forestry, including planting of millions of pine seedlings to assure its softwood supply. In addition, the pulpwood supply is but 10% of the total drain which approximates the 10.8% drain due to diseases and insects. National and local campaigns of forest fire prevention and insect controls aimed at minimizing these losses have been vigorously supplemented and supported by pulp manufacturers. Most of the lands owned by industry members are well protected with trained fire-fighting outfits.

Capital Investment

In the war period (1939–45), the paper industry's investment per worker rose from $17,100 to $18,700, or 8%. In the postwar period, with its rising wage rates and material costs, the average investment per

† Source: Securities and Exchange Commission.

* Source: U. S. Forest Service.

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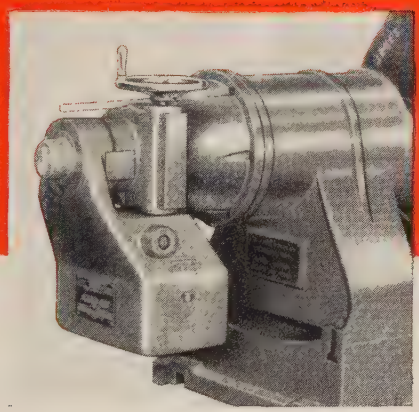

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worker rose to $31,100 in 1951,* a further increase of 66%. This is a high investment per worker and supports the statement that the papermaking industry is one of high capital investment. In much of the industry, productivity has been sharply increased as a result of this investment and labor cost per ton has been held in check as a consequence.

Compared with the paper industry's $22,400 investment per production worker* in 1947 are the following:†

Chemicals and allied products	$29,088
Metal products and processes	7,275
Food and beverages	10,036
Tobacco manufacturers	21,708
Lumber and wood products	3,809
Automobiles	8,624
Iron and steel, nonferrous metals, and products	7,309
Total manufacturing	7,713

The average investment per ton of daily capacity rose from $43,000 in 1945 to $81,000 in 1951. All these average investment figures include a considerable amount of old low-cost and depreciated machinery, buildings, and equipment. Current estimates on new construction costs run to $100,000 a daily ton of capacity with variations depending upon location, type of product, and other factors.

The Labor Factor

An estimate of industry-wide labor cost per ton runs currently at about $40.50 for papers made from chemical wood pulp. This indicates that average labor cost is about 25% of the average sales price of $164.

Grade labor costs may run from $22 a ton on kraft container board to over $100 a ton for rag content fine papers, as there are great differences in the amount of labor needed to produce the different grades and qualities of paper desired by the many types of customers served by the industry.

As in all other industries, wages have increased sharply in the papermaking industry during the war and postwar period. Since 1939, average hourly earnings have risen by 175% and average weekly earnings by 210%.‡ Increases in the "cost of living" have brought the weekly earnings figure down in terms of purchasing power, but, even after allowing for this, "real weekly earnings" are 65%‡ higher than in the prewar period. In addition to these increases in purchasing power, the wage earners of today enjoy many fringe benefits which cost the employer real money. The U. S. Chamber of Commerce in a recent survey indicated that in 1951 these fringe benefits were 14.8% of payrolls, 24.8¢ per payroll hour, and $535 per year per employee in the pulp, paper, lumber, and furniture industries.

The Cost Picture—A Summary

1. *Material Costs.* The paper and pulp manufacturers have expanded their raw material base by bringing into use through technical progress, added supplies of wood, thus keeping down raw material costs.

2. *Labor Costs.* Wage rates have advanced sharply in line with other industries but through investments in new plant and equipment average productivity has been increased by 54% from 1939 to 1951. The increase in productivity is not uniform by grade and is far from uniform by mills but the net result is to minimize the effect of the very sharp increase in wages on the average labor cost per ton.

3. *Other Costs.* Other costs may for convenience be lumped into one group which may be called overhead. The dollar volume of these costs has been increased by the general inflation. Salaries have been increased and depreciation charges have been raised by tripling of construction costs on new plants and in some cases by accelerated amortization. The volume of this new construction may be realized when we understand that through 1952 the paper and allied products industry has spent $2,401,000,000 on new construction since the end of World War II in 1945. This compares with estimated total pulp and paper mill assets of $2,970,000,000 at the end of 1945. This year the industry is spending $380,000,000 on new plants, according to surveys by the U. S. Department of Commerce.

The 54% increase in productivity from 1939 and the 31% increase since 1945* help considerably to reduce the overhead unit cost and so to counteract in part these large increases in overhead.

The high ratios of production to capacity which have prevailed in recent years also operate to decrease costs and increase average profit ratios for those years.

Over-all Industry Movements—Prices

The movements in prices are indicated in two charts—Chart V extending from 1914 to the present, shows the long-term price picture.

This shows how the paper prices have moved closely with the B.L.S. "Wholesale Commodity Price Index" over almost 40 years, including two wartime inflationary periods and the 1930 depression.

Chart VI shows the current short-term movements of the B.L.S. "Wholesale Commodity Index" and two indexes of average value per ton, namely, the index for paperboard and the index for paper. These show that in the short-term movements, the B.L.S. Index has moved before the two other indexes in both the up and the down movements.

The Influence of Overseas Market Wood Pulp Prices on Paper Prices Has Changed. For years it has been taken for granted that paper prices have been moving up and down in response to changes in the market prices for wood pulp. This was the case 20 years ago when market pulp was a much higher percentage (22%) of total wood pulp supply than in 1952 when it was only about 13%. Of this 13%, about $^1/_2$ the volume of market pulp came from domestic pulp mills, $^3/_8$ from Canada, and $^1/_8$ from overseas. In the 1930's, 60% of market wood pulp came from overseas and European pulp prices dominated the United States pulp markets and indirectly the paper markets.

Fully and partially integrated paper mills now account for 87% of the total pulp consumption in paper and board. It is obvious that shifts in the price of overseas market wood pulp with less than 2% of the total volume consumed, have ceased to dominate the paper market.

In the post-Korean pulp market, prices of United States produced market wood pulp have been steady. Canadian producers have been slightly above United

* Sources: "A Capital and Income Survey of the U. S. Pulp & Paper Industry," American Paper & Pulp Association, New York, 1952.

† Source: Economic Almanac, 1952, The National Industrial Conference Board.

‡ Source: American Paper & Pulp Association.

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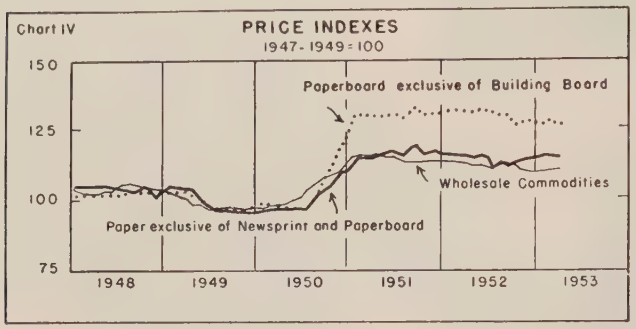
States producers in prices but European pulp was reported sold at such fantastic prices as $300 a ton compared with a U. S. ceiling price of $140 for the same grade. In the middle of 1951, O.P.S. put a ceiling price of $225 a ton on European pulp. This was the situation at the beginning of 1952. In the first half of the year, paper and board production dropped sharply and domestic consumers of overseas pulp cut off ship-



ments, thus reducing them to a mere trickle. Canadian shipments were curtailed but to a lesser degree. The overseas pulp producers dropped prices in the last half of the year so that by the end of 1952, they were about on a level with domestic producers. Canadian pulp producers have, as of May 1, 1953, brought their prices in line.

With all of these gyrations in the prices for market wood pulp, there has been little effect on the indexes of average value per ton of paper and board. On the other hand, the 1952 drop in paper production very definitely had a dominant effect on the price of market wood pulp from overseas.

Changes Since the 1930's. An important consideration in the economic behavior of the United States paper market is its present relative independence of the European sources of wood pulp supply which so dominated it in the 1930's and led to so much disturbance and confusion in the price structure. European pulp supply prices can influence the present market, but with only 2% of the total United States pulp supply, European pulp can hardly dominate.

FORECASTS

Interrelation Between Price, Orders, and Production

The B.L.S. "Wholesale Commodity Price Index" has been dropping gradually since February, 1951, but the paper and paperboard price indexes reached peaks about 7 months later (September, 1951) and then moved gradually downward (see Chart IV). Accompanying these downward movements of prices, orders for paper and board slackened, and later, production dropped below consumption. The Basic Demand Study (see Chart VI) shows that this condition of under production continued through July of 1952, at which time inventories in the hands of consumers had reached a turning point in both paper and paperboard. Since then, production has risen (Chart VI) and the price indexes have leveled off in both paper and paperboard (Chart IV).

Future Price Levels

The B.L.S. "Wholesale Commodity Price Index" has also leveled off and apparently has stabilized at or close to 110 index points on a base of 1947-1949 = 100. On the assumption that there will be little movement up or down in this B.L.S. index for some little time, it seems reasonable to expect a fairly steady price level in the paper industry.

Effect of Stable Price Level

With stable price levels in general business and in the paper industry, there will not be the incentive of rising prices for customers to stock up. A more normal competitive climate is likely to prevail in which production of paper and board will hold closer to consumption than it has in the recent past.

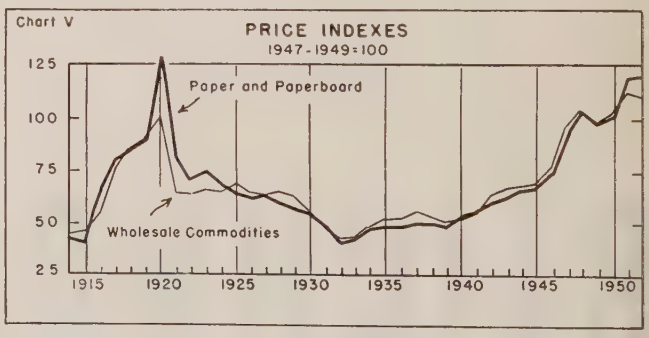
Under these circumstances, the production curve can be expected to follow consumption more closely than in recent years. A sudden decision by customers and the general consuming public to change inventory policies could throw production up or down, but with a stable price level in prospect, such a change is not considered likely unless the international scene erupts violently.

Paperboard Production

The position of the production index of paperboard as of March, 1953, the latest available data, was slightly above the consumption or basic demand line (see Chart VI). It has risen from an extended period in which production was below the consumption line, because customers of the industry were reducing inventories to a point where customers' rebuilding of inventories is indicated. The current flow of production should be maintained above consumption by this customer rebuilding of inventories. This could reach well into the fourth quarter if not into next year.

Paper Production

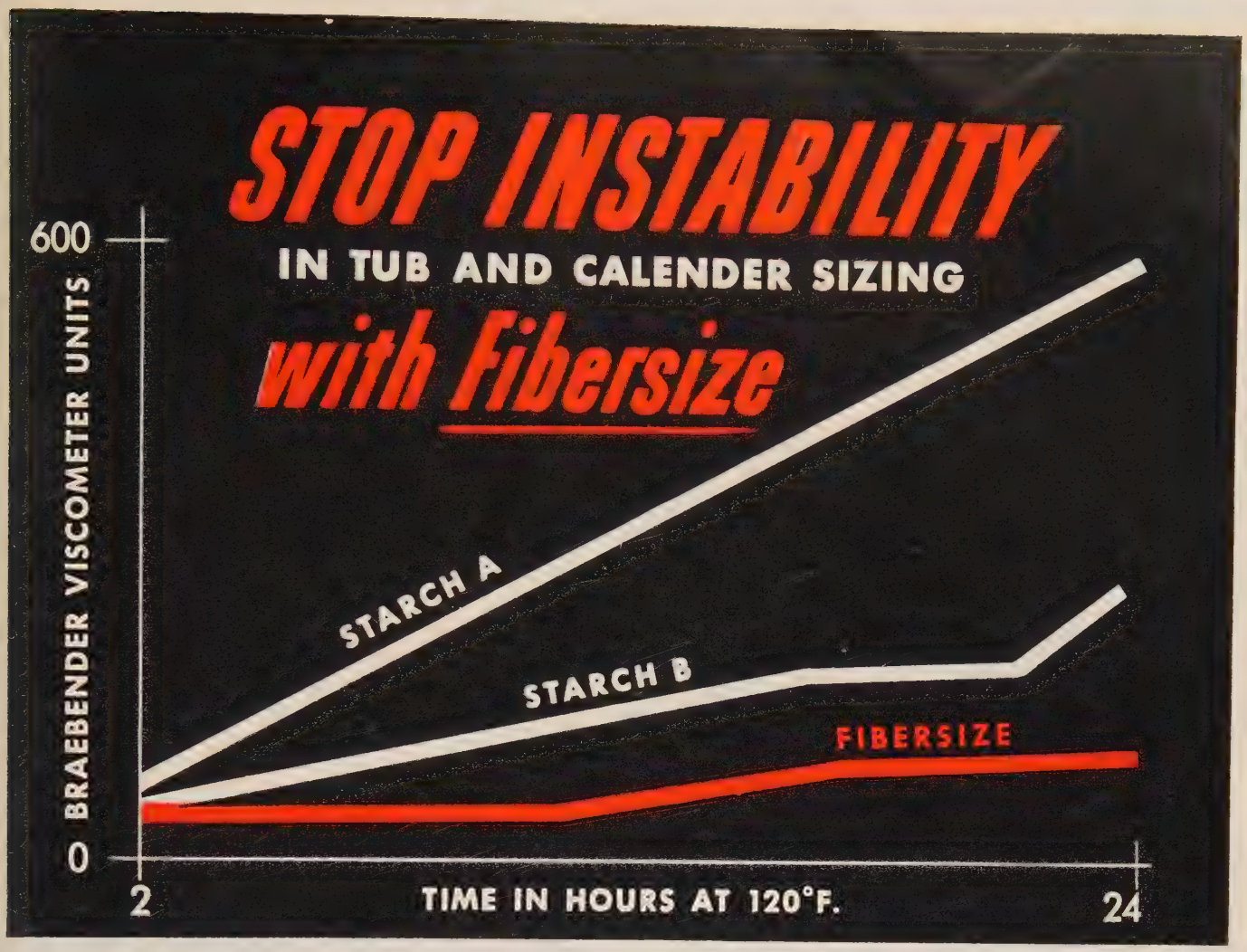
The paper group is currently in a stronger position. From July, 1952, to March, 1953, consumption was greater than production with the result that customers' inventories have been depleted to practically bedrock. It will require a period of almost full production to bring these inventories back to normal if consumption continues at its March level.



Order Backlogs

Order backlogs in both paper and paperboard have risen since the middle of 1952 with paper showing the greater rise in terms of "days to run."

The paper segment's production usually starts upward later than in paperboard just as paper prices have moved more sluggishly than paperboard prices.



The graph tells the story of FIBERSIZE's performance—its amazing stability as compared with competitive starches.

Now, about the product . . . it's an oxidized starch that gives you *controlled penetration* in tub and calender sizing. It holds its viscosity over long periods of time. It won't become viscous and stick to rolls, causing paper to tear.

FIBERSIZE also has better strength characteristics than enzyme-converted starches. It has good clarity, permitting increased brightness and gloss of the sheet. And it is excellent for use in glassine and other grease-proofing operations.

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I'D LIKE TO STOP INSTABILITY in tub and calender sizing.

Please send—

☐ Technical data on FIBERSIZE

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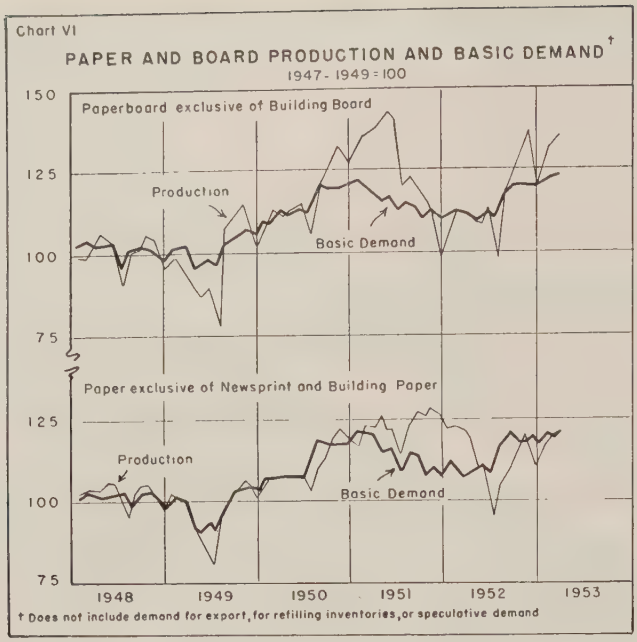
National STARCH PRODUCTS



As a consequence of this slower start, the paper segment can be expected to continue to maintain high volume production well into the Fall and this should carry into next year.

Production Ratios

Both major branches of the industry, paper and paperboard, have recently been operating at high levels even after taking into account increased capacities in both segments. The high ratios of production to capacity in the paperboard group contrast with the 1952 first quarter's result which shows for the months of January, February, and March an operating ratio of 84% of capacity as against 94% in 1953.*

These higher ratios of production to capacity indicate higher earnings before taxes this year than last. The net after taxes will of course reflect any changes in tax rates.

Future Capacity Increases

The aim of the manufacturer is to maintain his own production ratio at as high a point as possible. That paper manufacturers have been successful in doing this over a considerable period is not open to doubt. Some analysts have become fearful about the planned expansion in the industry, particularly for the manufacture of wood pulp and paperboard.

It has been shown that the paper and board industry has very high growth factors in certain segments. One of these high growth segments is that of paperboard. Planned new capacity in this field is expected to increase rather sharply in the next two or three years. It might prove to be that for a period the paperboard production *ratio* may drop until the high growth factor has had time to bring production up to the capacity increases. Paperboard manufacturers' profits might drop for a short period. However, it is believed that marginal mills making the "jute" grades will take the brunt of the loss in earnings. Mills making kraft paperboard grades have grown consistently through good and bad years. It seems possible that kraft paper board may even increase while the other grades are decreasing.

A moderate amount of excess capacity will be healthy and will provide time and facilities to develop new and better products.

Pulp Capacity Increases

This leads to the consideration of the planned increase in pulp-making capacity which was mentioned earlier. While it is true that planned new capacity indicates a more rapid increase in pulp capacity than in paper and boardmaking capacity, two important factors should be recognized, namely:

1. The percentage of wood pulp consumed to other fibers consumed in the papermaking process has steadily increased since 1945. This is in part due to improvement in quality by making the raw material mix richer in wood pulp and in part due to the competitive advantages of some of the wood pulp grades which have been previously mentioned.

2. Practically all of the planned new pulp-making capacity is directly integrated to papermaking capacity. In the event of a surplus of market pulp, it is not liable to be thrown on the market. The major exceptions to this are the pulp mills built for making dissolving wood pulp, of which there appears to be adequate capacity now available. It seems doubtful that this tonnage can or will damage or disrupt the paper market.

Long-Term Forecast

All in all, the capacity increases appear to be planned to meet normal growth and it is to be expected that they will be handled intelligently by the responsible and informed executives of the individual companies that may be involved. The strong upward growth in the industry's production is expected to continue. There is nothing in the present outlook that indicates other conclusions than that the normal ebb and flow of competitive business should be expected in the foreseeable future of the paper and board industry. Managements are alert and are developing the consumption of both paper and board in aggressive fashion and the growth patterns of the industry should continue their long-term upward trends.

A domestic production of 30 million tons of paper and paperboard by 1955 is quite possible under boom conditions. Long-term growth patterns indicate the possibility of 57,000,000 tons United States consumption by 1975. These figures may be compared with 1951 United States domestic production of 26,000,000 tons and apparent consumption of 30,700,000 tons, both of them records.

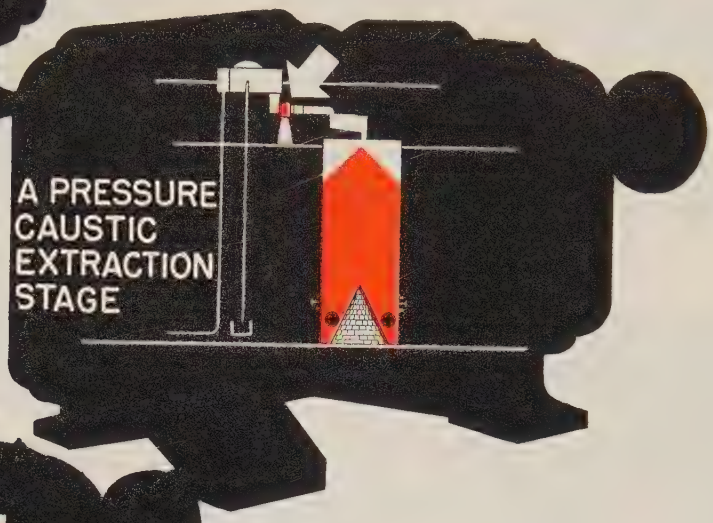
1953 Forecast

Present indications are that paper and board production in 1953 will equal or exceed the 26,000,000 tons made in 1951. But this production will be at a lower overall production ratio than the 103% of capacity shown in 1951, probably in the 90 to 95% range. Consequently, the earning *ratio* before taxes will be somewhat lower than in 1951 but higher than in 1952. The net after taxes for 1953 will depend upon applicable tax rates which are not certain at the moment (June, 1953).

* Source: National Paperboard Association

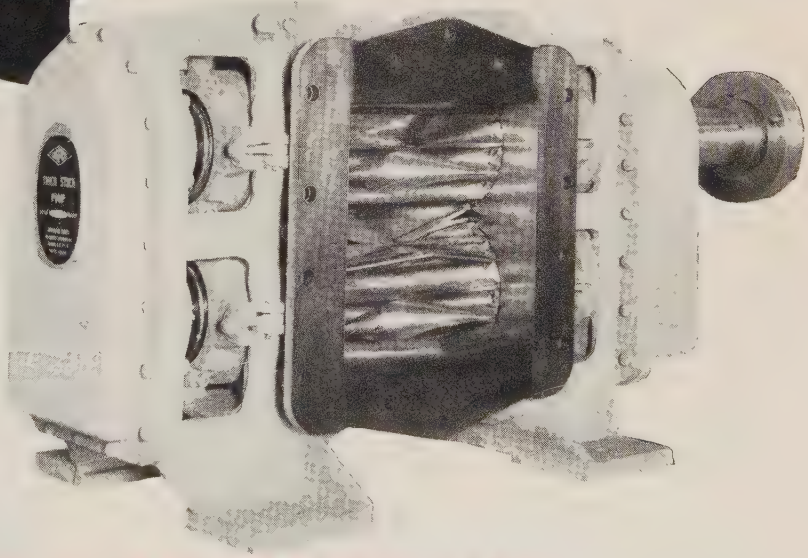
THICK STOCK PUMP

PUMPING 10%-17% PULP



IMPCO

SERIES - 300 *
SERIES - 500 *



This unit is a positive displacement type pump specifically designed to handle pulps at high densities. The conical profile of its synchronous rotors permits the pumping of stock at densities above 10% A.D. — with lowest horsepower per ton — and no fibre damage. Truly the modern way to handle all types of pulp.

* Tons per day.

IMPROVED MACHINERY INC.

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Sherbrooke Machineries Limited manufacture similar equipment in Canada.

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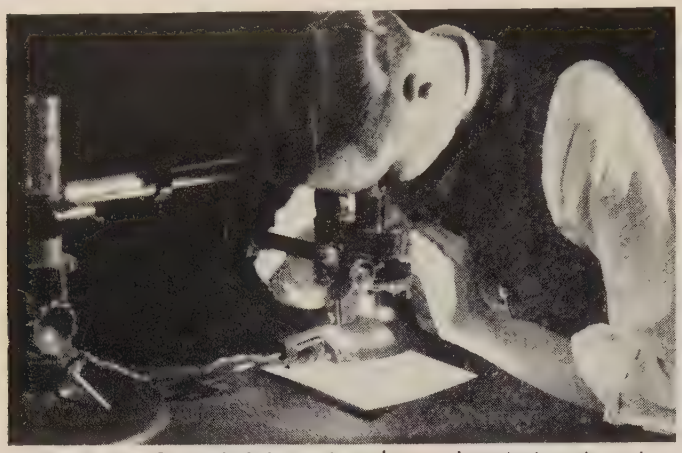
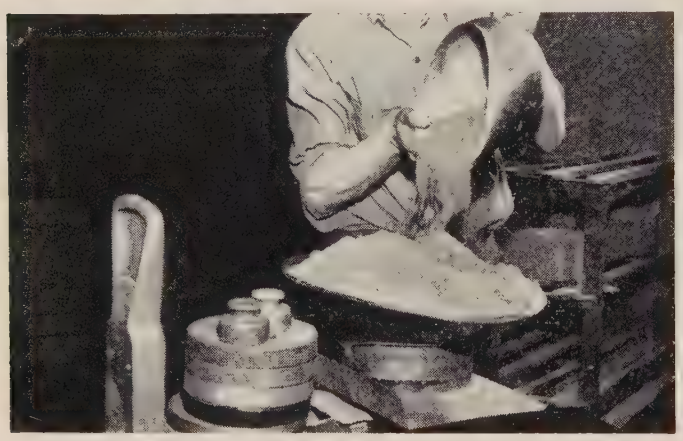
Precision Manufactured to Meet Your Requirements

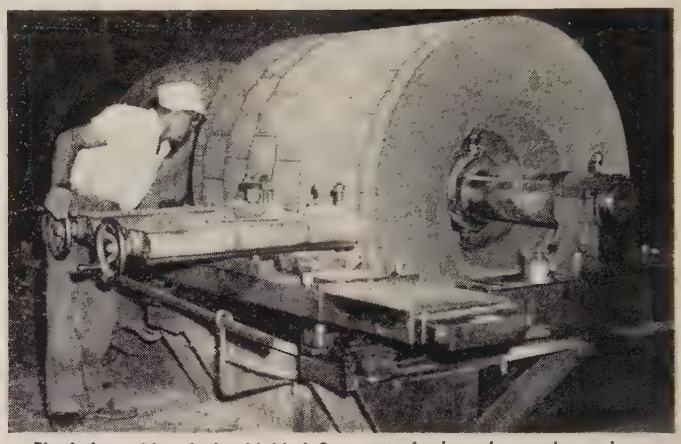


The Norton Research Laboratories play an important part — not only in continually improving the Norton Pulpstone but in the routine checking of materials quality.

From the Norton Electric Plants come the abrasives used in making the Norton Pulpstone — here you see a resistance type furnace producing CRYSTOLON abrasive.



The Most Modern Factory Equipment is used in making the Norton Pulpstone. Here a workman is weighing out the exact amount of abrasive and bond required for molding a segment.



Final Assembly of the Molded Segments is done by workmen long skilled in this exacting job. This is followed by careful truing of the completed stone in a gigantic lathe.

THE Norton Pulpstone is not an "artificial" stone — it is a real precision *manufactured* pulpstone — carefully engineered to meet your special requirements. First the abrasive is *manufactured* in the Norton electric furnace plant — from bauxite ore if it is an ALUNDUM stone or from silica sand and metallurgical coke if it is CRYSTOLON stone.

Then in the mile-long Norton Worcester plant, the world's largest grinding wheel plant, the abrasive is mixed with suitable bonds and molded into segments. After being kiln-fired the segments are assembled to form the final stone. Every step in the manufacturing process is under careful quality control and every element in your stone is exactly tailored to meet your particular requirements.

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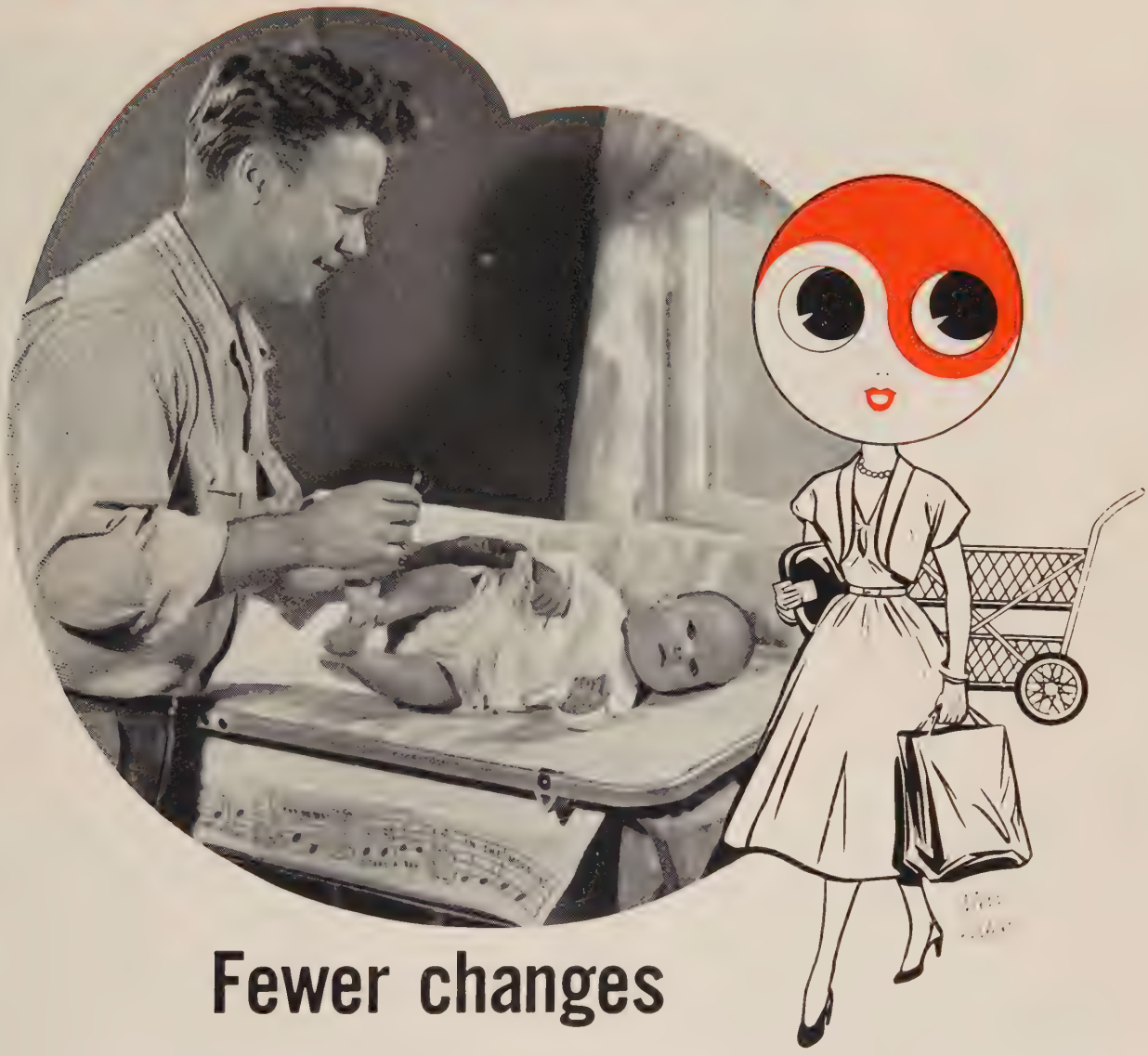

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NEW MASONEILAN 12000 SERIES

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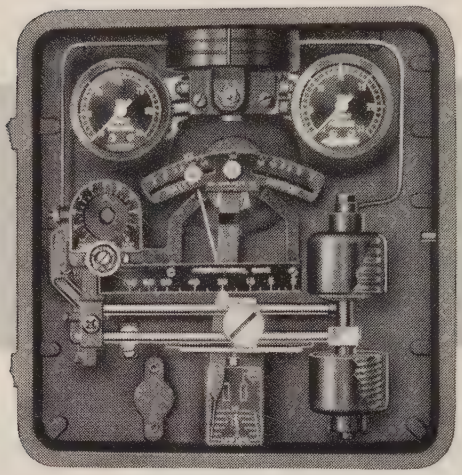
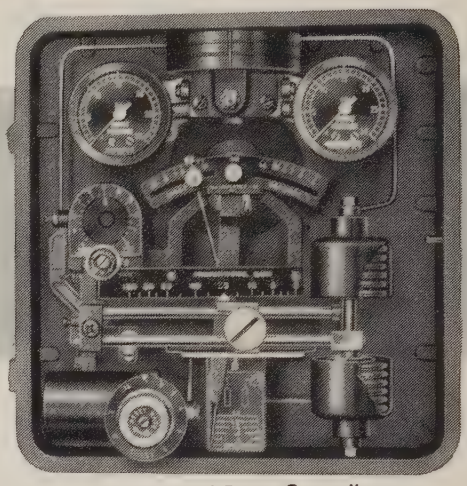


Proportional Controller



Proportional-Reset Controller

These new controllers reflect a realistic blending of past experience and current design trends, combining advanced features which reduce weight, improve adjustability and increase ease of selection, installation and servicing.

Consider what these design improvements can mean to you . . .

UNIT CONSTRUCTION

Unit subassemblies of the control mechanisms (proportional, or proportional-reset, unit and level setting mechanism) are mounted on the mechanism bracket which is in turn rigidly attached, piloted and doweled to the torque tube housing. Thus, individual units are fixed in position, unaffected by possible distortion of the case, yet are readily removable for servicing or interchange. Other sub-assemblies (pilot and manifold) are mounted in the rugged aluminum case which is finished and gasketed for outdoor service. Cover is closed by a positive cam-type latch.

SIMPLE AIR CIRCUITS

The high-capacity, balanced, amplifying, pilot with frictionless floating-action valve and cleanable sapphire orifice, is connected to the forged brass manifold which contains most air passages. Tubing in the proportional controller is limited to two short lines. The nozzle is easily removable for cleaning, and after replacement requires no aligning. Special ring type adapters facilitate connections.

EASE OF ADJUSTMENT

Proportional band setting . . . is made on a rod-type cantilever spring by a self-aligning clamp tightened by a large knurled knob located in front of the mechanism. A four-inch direct reading scale indicates the setting.

Control action and specific gravity setting . . . are selected by attaching the control link to desired side of reversing arc along the specific gravity scale, graduated from 0.5 to 1.4. The arc is easily reversible when instrument mounting is changed to opposite side of displacer.

Set point . . . is precisely adjustable throughout entire range by turning setting knob over 270° arc scale, 2″ long. Scale is reversible when control action is changed.

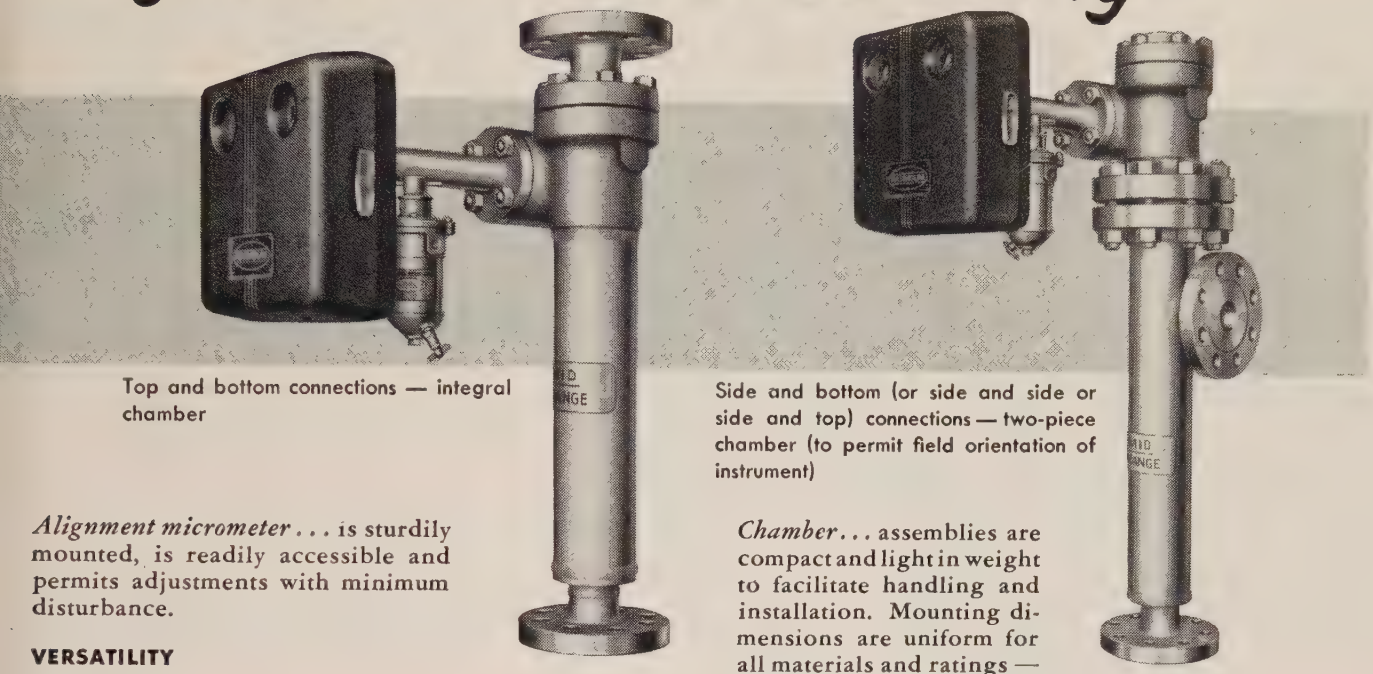
Direct level indication . . . is provided by a sturdy pointer fastened directly to the torque tube rod. The scale is graduated for both left and right hand instrument mounting and for several specific gravities.

FOR A WIDE VARIETY OF APPLICATIONS

LIQUID LEVEL CONTROLLERS . . .

Dependable Control — plus

Adjustment and Servicing



Top and bottom connections — integral chamber

Side and bottom (or side and side or side and top) connections — two-piece chamber (to permit field orientation of instrument)

Alignment micrometer . . . is sturdily mounted, is readily accessible and permits adjustments with minimum disturbance.

VERSATILITY

The proportional controller . . . may be used as a *Transmitter* and can be converted in the field to a

Differential gap controller . . . by simply reversing position of the coil spring and bellows in the proportional unit; or

Proportional-reset controller . . . by interchanging the proportional unit and the proportional-reset unit.

STURDY, COMPACT, ACCURATE MEASURING UNIT

All parts of the *Torque Tube Assembly* are made of a single alloy, individual parts being welded to form an integral unit. Knife-edge bearings support both ends of torque tube. Torque tube housing is removable from mechanism chamber.

Stainless . . . steel tubing *Displacers* designed so that standard control mechanism can be used for all ranges, are attached to the torque arm by hangers with modified-knife-edge hooks. Hanger extensions may be integral or detachable.

Chamber . . . assemblies are compact and light in weight to facilitate handling and installation. Mounting dimensions are uniform for all materials and ratings — and are in whole numbers; on side-mounted types mounting dimensions equal level range.

VARIETY OF TYPES, MOUNTINGS, MATERIALS

Instrument Types include *Proportional, Proportional-reset, Differential Gap Controllers* and *Transmitters;* or any combination of two of these in larger case. *Mounting Types* include top and bottom, side and side or side and either top or bottom, with screwed or flanged connections; also top or side of vessel with flanged connections. Instrument mounting left or right of displacer.

Ratings up to 2500 lbs. ASA.

Materials include iron (14″ & 32″ only), steel or alloy chambers; stainless steel displacers; inconel (or wide selection of other materials) torque tube assemblies.

Ranges — 14″, 32″, 48″, 60″, 72″, 84″, 96″, 120″

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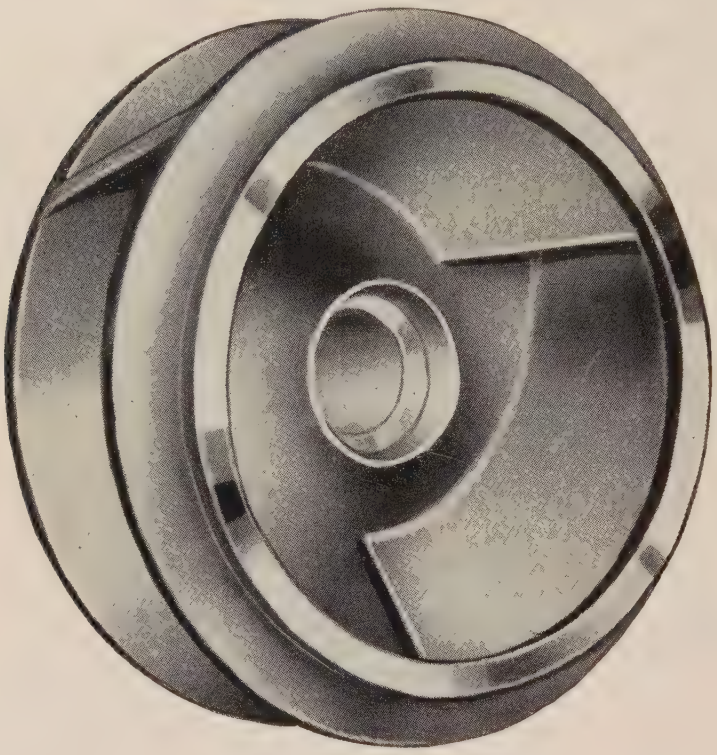
IN THE PULP AND PAPER INDUSTRIES

"Buffalo"

Tips on Better Pumping

Below, "Buffalo" non-clogging enclosed impeller of a type to be found in many "Buffalo" Paper Stock Pumps.



ADVANTAGES OF ENCLOSED NON-CLOGGING IMPELLERS OVER OPEN TYPES FOR PAPER STOCKS

1 FREEDOM FROM WEAR AND WEDGING

Note in the above impeller that vanes are shrouded. No wearing plates or close running tolerances are required, thus, there is little possibility of wedging or wear, even with high consistency stocks.

2 NO LOSS IN EFFICIENCY

Since the enclosed impeller does not depend on close running tolerances for its high efficiency (unlike open type impellers), initial high efficiency is retained indefinitely.

3 LOW UPKEEP

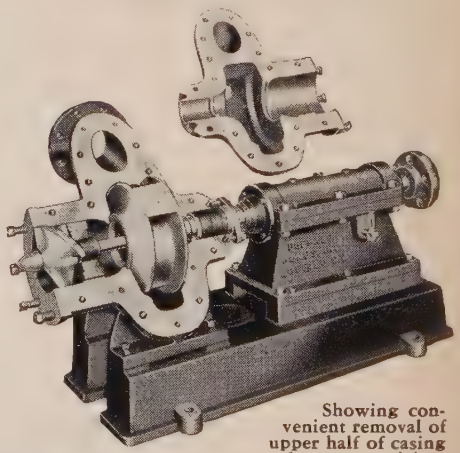
High-consistency stocks pass through as easily as through pipe. Freedom from clogging means low upkeep.

4 GREATER STRENGTH

Enclosed impellers like the one above, being shrouded, have greater strength to resist the shocks incident to paper service than open impellers. Note the sturdy design of the "Buffalo" impeller shown.

5 LOW COST STOCK PUMPING

The Diagonally Split-Shell Pump at right is one of many "Buffalo" types to give you low-cost service on any stock. Have us mail you Bulletin 953, with the engineering details.



Showing convenient removal of upper half of casing for easy servicing.

"Buffalo" BUFFALO PUMPS, INC.

528 BROADWAY BUFFALO, N. Y.

Subsidiary of Buffalo Forge Company

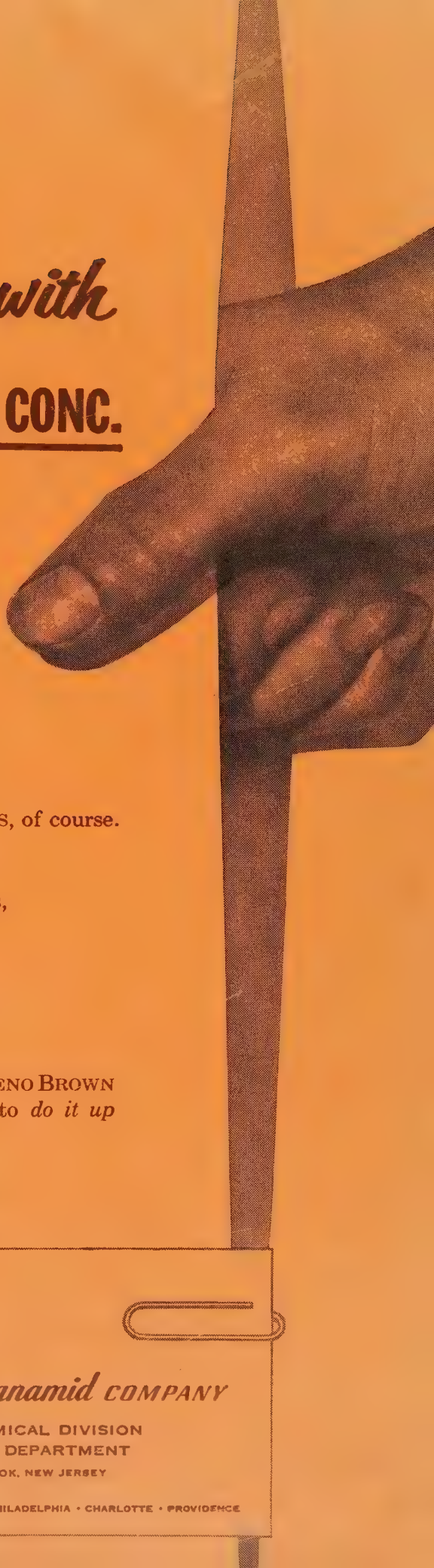
Canada Pumps, Ltd., Kitchener, Ont. Sales Representatives in all Principal Cities

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

let's do it up Brown with

PHENO BROWN 3GXX SUPER CONC.

DUSTLESS



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Bag, tissue, wrapping, board and specialty papers.

How . . .
With PHENO BROWN 3GXX SUPER CONC., DUSTLESS, of course.

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Why . . .
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Burnt Sienna Raw Sienna Burnt Umber Raw Umber Ochres	Blacks—Mineral & Paris Coating Pulps Chrome—Greens, Oranges & Yellows Calcotone Pastes Molybdate Oranges Red Iron Oxides Ultramarine Blues (Dry and Pulp) Unitane® (Titanium Dioxide, Anatase and Rutile)

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Calcotone* (Pigment Dispersions)
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Sap Brown—Crystal and Powder Dark Brown S
Soluble American Blue (Soluble Iron Blue)
Spirit Dybryte* (Bleed Fast Spirit Soluble Dyes)

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CALCO CHEMICAL DIVISION
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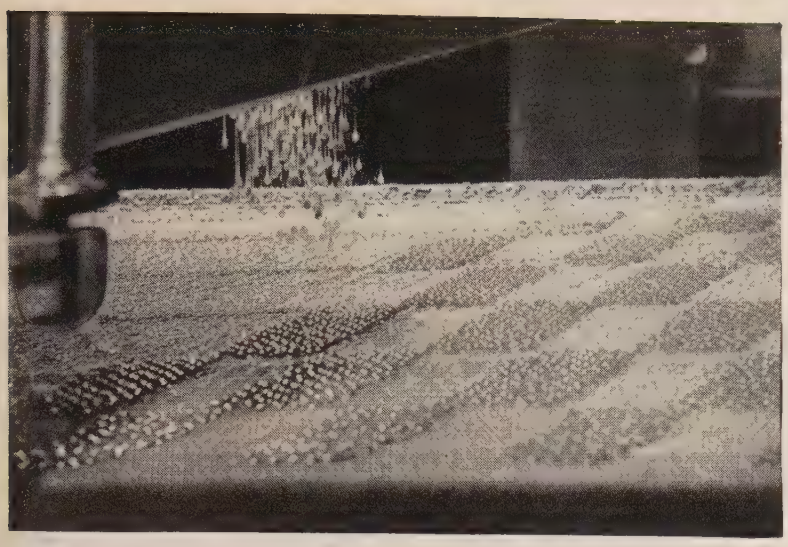

Just one phase of Swift's exclusive process—the glue liquor falls on a bed of dry finished product and moves through a virtually closed drying system. No chance for contact with contaminating substances.

Attention paper producers!

Only Swift can give you New Process Glue

A product of unexcelled purity and uniformity, New Process Glue is *exclusive* with Swift. Only Swift has the facilities to manufacture this quality glue for paper makers.

In Swift's exclusive process, protein liquor is scientifically extracted from fresh, selected raw material. The concentrated liquor falls in drops on a moving belt of dry glue. Then, by continuous and automatic process, the product is dried, milled and screened. During the entire manufacturing process and in finished form, the product must pass rigid laboratory tests . . . meet a number of chemical and physical requirements.

Uncontaminated by foreign substances—New Process Glue is a clean, light-colored, uniform product.

Here's where Swift's New Process Glue serves the paper producer

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● ***IN FLOTATION-TYPE SAVEALL SYSTEMS*** — New Process Glue helps obtain clearer effluents because of its unusual ability to flock fibers and fillers.

● ***IN GETTING HIGHER PICK TEST*** — New Process Glue is used as a partial replacement for starch in machine coating. It promotes better film formation and greater tensile strength than a total starch solution.

SWIFT & COMPANY
Adhesive Products Department
Chicago 9, Illinois

Please send your 100-lb. introductory shipment of Swift's New Process Glue at the quantity price, to be tested for use in our operations. We understand, if not fully satisfactory, it may be returned for credit at your expense.

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FILLERS A wide range of Dicalite Fillers serve the differing needs of a long list of industries, from building materials through dyes, plastics, paper, paint, textiles, and many others.

PAPER AIDS Dicalite used in the "furnish" in the making of paper and paper-board products, provide so many advantages that they are widely used throughout the paper-making industry.

EXTENDERS AND FLATTING AGENTS Dicalite materials are widely used as extenders and flatting agents in both inside and outside paints, varnishes, enamels and lacquers. They produce flatting to any desired degree and generally improve adhesion, drying, durability and color dispersion.

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DICALITE FOR CONCRETE To improve workability and strength, eliminate excess water and decrease placing and finishing costs, Dicalite is used in many types of concrete construction.

DICALITE INSULATION Employed to reduce heat waste, save fuel and increase efficiency in almost every type of heated equipment used today. Available for service at temperatures up to 2100°F.

Your Dicalite Engineer can bring light into your processing problems

While your Dicalite Engineer may be somewhat surprised at being called a searchlight, that is his job, essentially — to throw light on operating difficulties and clear them away. His intimate, detailed knowledge of diatomaceous materials and his wide experience in their applications will often solve an operating problem quickly. But, if necessary, he'll spend days working with you and your operators, ironing out difficulties or perhaps, aiding you in working out details for a projected new process.

Whether your problems involve filtration, fillers or any other use of diatomaceous silica, his expert services are always at your call. For extremely complex problems, you can call on the services of the fully-equipped Dicalite laboratories, who will spend weeks if necessary to get you the right answer.

Our crowded files of years past show how great the value of Dicalite Engineering Service is — to you and to us, also. For we are as interested as you in seeing to it that, when you get Dicalite, you get the *results* you want!

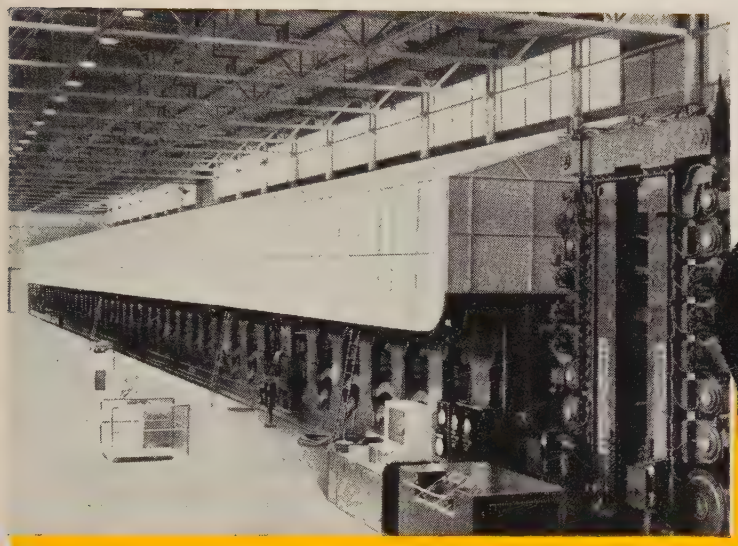
Dependable GREAT LAKES Dicalite® DIATOMACEOUS MATERIALS

DICALITE DIVISION, GREAT LAKES CARBON CORPORATION • NEW YORK 17 • CHICAGO 1 • LOS ANGELES 17

KRAFT CENTER—Pensacola, Fla.

is the latest of the major installations of

ROSS AIR SYSTEMS IN 13 MILLS OF THE ST. REGIS PAPER CO.



In one after another of its many busy mills distributed over eight states in the U.S.A. (and others in Canada), the great ST. REGIS PAPER CO. has chosen ROSS Systems for all its air handling problems. At Kraft Center in Pensacola, Fla. ROSS equipment includes:—

Machine Hood and Exhaust
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ROSS SYSTEMS

J. O. ROSS ENGINEERING CORPORATION

MANUFACTURERS OF AIR PROCESSING SYSTEMS

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The Trade Name for Top Quality

SCREEN PLATES

MEET THE EXACTING DEMANDS OF CANADIAN PULP AND PAPER MILLS

The quality and dependability of UNION Screen Plates are backed by over forty years' experience in satisfying the needs of Canadian pulp and paper mills.

GIVE MAXIMUM PERFORMANCE UNDER ALL CONDITIONS

UNION Screen Plates are made in our own foundry to our own special formula, using the best materials available. Our laboratory-trained experts control all operations, thus ensuring the utmost satisfaction and value in service.

ALL STYLES AND TYPES AVAILABLE

UNION can supply Screen Plates in any style of cut or number of slots per inch; Chromium Plated, Stainless Steel, Cast Bronze, Phosphor Bronze, Inconel and Rolled Copper. Special Plates also made to order.

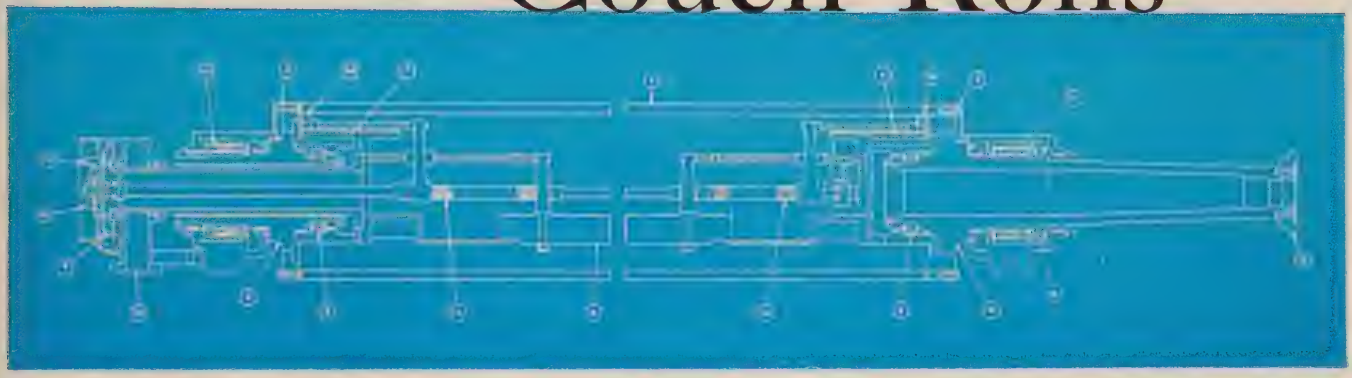
UNION also manufactures a complete line of Screen Plate accessories.

UNION SCREEN PLATE COMPANY OF CANADA LIMITED

Head Office and Plant: Lennoxville, Que. Sales Offices: Montreal and Toronto.

THE KEY TO EFFICIENT WATER REMOVAL ON FOURDRINIERS

Downingtown Suction Cantilever Couch Rolls



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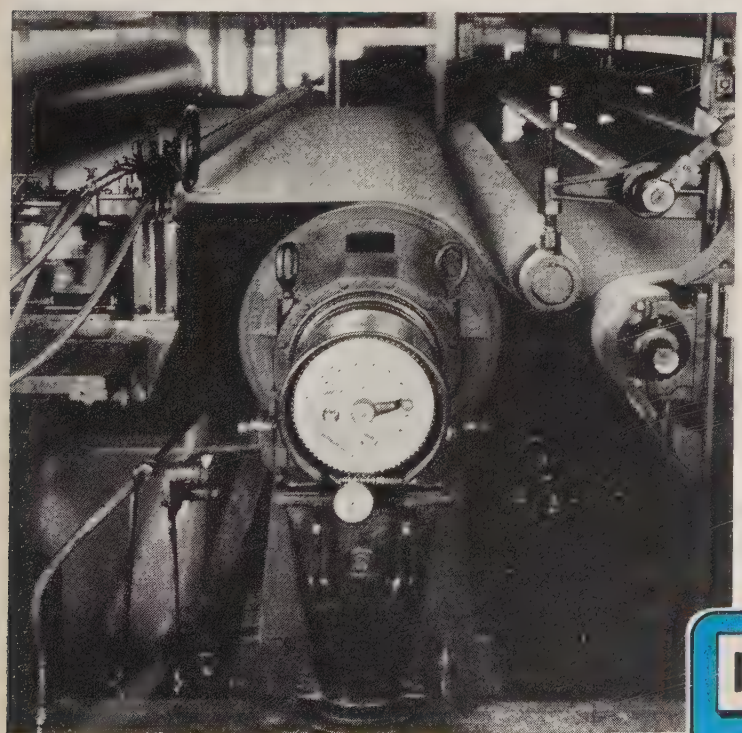
2. Alloy Steel Shell Studs
3. Front Head
4. Rear Head
5. Internal Roller Bearings
6. Suction Box
7. Front Head—Suction Box
8. Rear Head—Suction Box
9. Worm Wheel Gear
10. Front and Rear Deckle Gears
11. Packing Strip Adjustment
12. Suction Elbow
13. Front and Rear Deckle Screws
14. Deckle Heads
15. Coupling to Drive
16. Front Main Bearing
17. Rear Main Bearing
18. Thrust Bearing



Downingtown Suction Cantilever Couch Roll showing adjusting mechanism and hood guard.

Because of Downingtown's long experience with the principle of water removal by the suction method, their Suction Cantilever Couch Roll is recognized as "standard" in the paper industry. The cantilevering feature is important because it permits easier and faster wire changing.

Downingtown Suction Cantilever Couch Rolls are furnished with suction connections either front or rear . . . and with single or multiple suction box openings. The experience of many mills shows that these Suction Cantilever Couch Rolls give long and efficient service and require a minimum of maintenance.

Write for a new bulletin "Suction Couch Rolls" which describes Downingtown Suction Cantilever Couch Rolls in detail.

DOWNINGTOWN MANUFACTURING CO.
DOWNINGTOWN, PA.

West Coast Representative:
John V. Roslund
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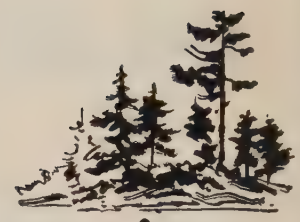
DOWNINGTOWN
DESIGNERS AND BUILDERS OF PAPER, BOARD AND FELT MACHINES SINCE 1880
MODERNIZATION IS PROFITABLE

You could hardly find a pulp or paper mill...

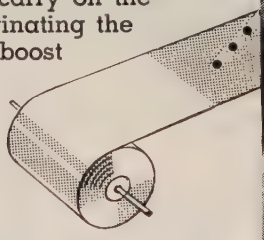


...for which instrumentation was not engineered at

FOXBORO

Process control instrumentation for nearly every leading pulp and paper mill in the United States and Canada has been *engineered at Foxboro.* The reason is simple. Foxboro engineering is based on acknowledged leadership — in knowledge of the industry's requirements, in research, in application experience, in product design and diversity.

In the labs and on the drawing boards at Foxboro, today, are tomorrow's developments for pulp and paper processes . . . developments that will carry on the Foxboro *tradition* of originating the instrument systems that boost production and increase quality and uniformity throughout the industry.



The Foxboro Company,
788 Neponset Avenue
Foxboro, Mass., U.S.A.

In the plans for nearly every modern mill, many hours of creative engineering work like this . . . AT FOXBORO . . . have played a vital part.

Leading mills know that extensive use of advanced instrumentation leads to operating efficiencies never before possible. Significantly, of the industry's newest mills, an overwhelming majority selected Foxboro to engineer and supply mill-wide instrumentation. Typical examples include:

*Rayonier, Inc., Doctortown, Ga.
*Buckeye Cellulose Corp., Perry, Fla.
Riegel Carolina Corp., Acme, N. C.
Brown Co., Berlin, N. H.
Southern Paperboard Corp., Port Wenthworth, Ga.
Macon Kraft Company, Macon, Ga.
Weyerhaeuser, Pulp Div., Longview, Wash.
Weyerhaeuser, Pulp Div., Springfield, Ore.
Marathon Paper Mills of Canada, Ltd., Marathon, Ont.
Long Lac Pulp & Paper Co., Ltd., Terrace Bay, Ont.
Columbia Cellulose Co., Ltd., Watson Island, B. C.
Sorg Pulp Co., Ltd., Port Mellon, B. C.
St. Lawrence Corp., Ltd., Red Rock, Ont.
Fraser Companies, Ltd., Newcastle, N. B.
MacMillan & Bloedel, Ltd.,
Harmac Div., Nanaimo, B. C.

*Under construction

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Pulp and Paper Mill INSTRUMENTATION

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

Quality Paper Making calls for OK BRAND STARCHES

for tub, beater and calender sizing—
for coating and adhesives

FREE TECHNICAL SERVICE!

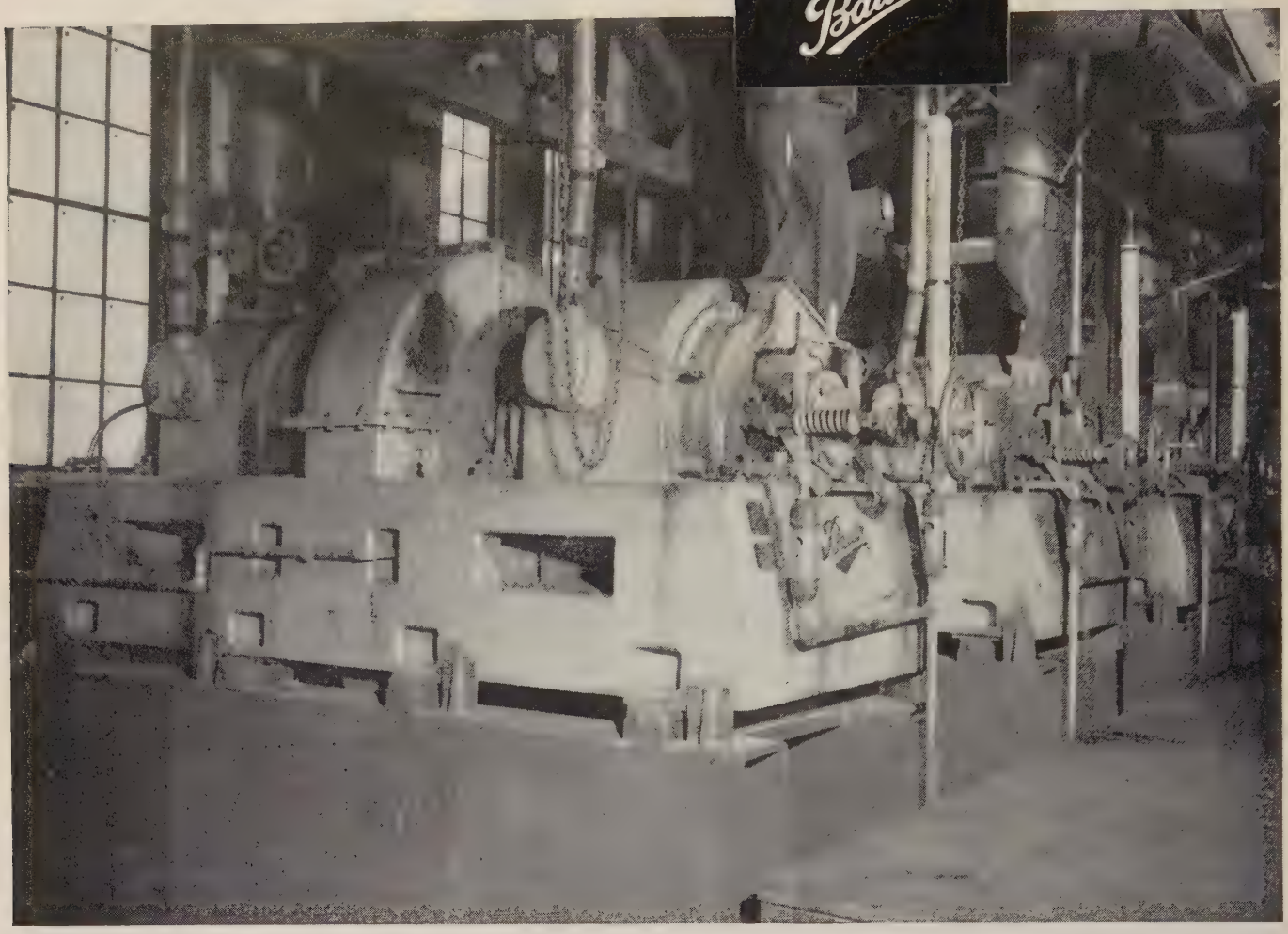
Some of the industry's outstanding experts in the use of starch in paper making are on the staff of Hubinger's famous laboratories. You are invited to consult these experts on your production problems—without cost or obligation on your part.

...the Stamp of Quality!

THE HUBINGER CO. (EST. 1881), KEOKUK, IOWA

Branch offices: New York • Boston • Charlotte • Chicago • Los Angeles

Veneer waste defiberized in Bauer Refiners



Shown in the above photograph are three Bauer No. 400 Refiners in the hardboard plant of The Coos Bay Lumber Company, Coos Bay, Oregon.

After log centers and veneer trimmings are chipped, the chips are steamed for 5 to 20 minutes. In due course, the semi-dry chips are fed into the Bauer refiners. Each refiner is equipped with two sets of discs rotating in opposite directions.

The rubbing action of the discs separates the chips into fibers. This is called "defiberizing" according to THE DICTIONARY OF PAPER—"The separation of fiber bundles into their individual fibers."

From the refiners the "pulp" goes to a blender where binders are added. Eventually, the fibers are fluffed and "snowed" down on a belt to a thickness of as much as six inches. A preliminary squeeze compresses the mat to permit sawing into sheets which are finally pressed into hardboard.

Of course, everyone in the pulp and paper industry recognizes the difference between the defiberizing of semi-dry chips and the refining of pulp slurry at 4% to 5% fluid consistency. Yet Bauer refiners are used with equal success for both processes, proving the adaptability of these versatile machines.

Further information on our refiners, both single and double revolving disc types, will be gladly furnished. You are invited to ask for our literature. Remember, too, that our research laboratory is available for testing the defiberizing, refining, reduction, or mullen development of any material in which you are interested.

THE BAUER BROS. CO.

1715 Sheridan Ave.
Springfield, Ohio

whys?

If you give a hoot about increased profits, it's wise to question why improved Pacemaker Waxes may be better for your operation. Write Cities Service Wax Dept. H34 Sixty Wall Tower, New York 5, New York.

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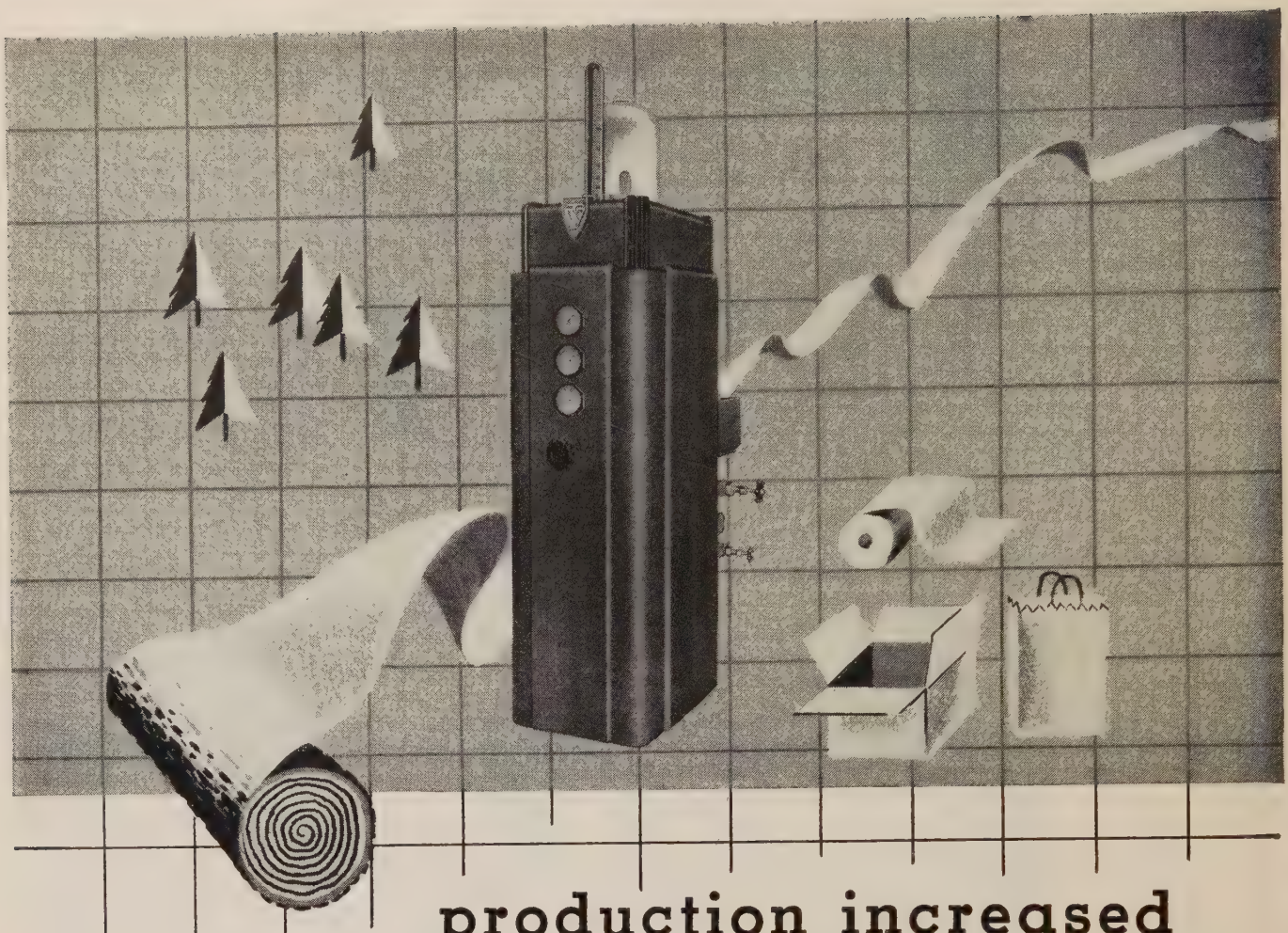


production increased up to 15 tons per day...

. . . with W & T chlorination equipment

A Southern mill had been having trouble with paper breaks attributable to the presence of slime in their white water. Despite continued efforts to control them slime breaks were running 60 to 80 per week, resulting in a time loss of 10 to 14 hours per week, and an average production loss of 15 tons per day! It was then that the W&T man was called in. Where and how to apply the proper treatment was determined, the costly methods were discontinued, and W&T chlorination was installed.

During the first 3 days of chlorination the mill recorded only 1 slime break and 2 minutes of lost time.

During the next 3 days there were 4 breaks and 17 minutes of lost time.

During the next 25 days there were no breaks attributable to slime!

. . . Within a week there were no production losses caused by slime! Performance such as that is typical of what your W&T representative can do for you.

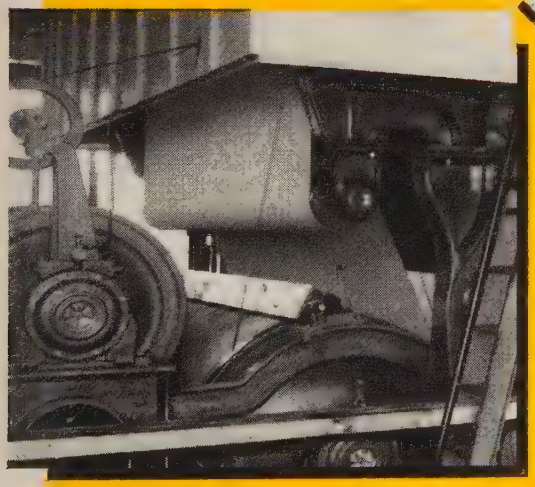
If you have a production problem attributable to impure water, it would pay you to write or call him now.

WALLACE & TIERNAN
COMPANY, INC.
CHLORINE AND CHEMICAL CONTROL EQUIPMENT
NEWARK 1, NEW JERSEY • REPRESENTED IN PRINCIPAL CITIES

I-42

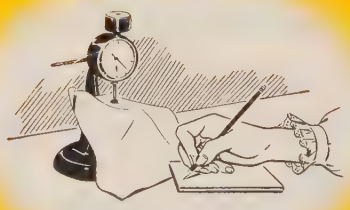
SCIENTIFIC CONSTRUCTION* Makes The Big Difference In DRYER FELTS

WOODBERRY 887 REINFORCED DRYER FELT GIVES YOU SCIENTIFIC CONSTRUCTION



*Asbestos yarns woven into the face of patented Woodberry 887 dryer felts at scientifically determined intervals give you longer wear and smoother operation. Paper mills have learned to count on lowered steam consumption and consistent quality with Woodberry 887. For dryer felts that are low on cost, high on performance, specify Woodberry 887.

One of a series of comprehensive laboratory controls throughout production to assure uniformity in all Mt. Vernon-Woodberry products. Here fabric thickness after weaving is being gauged.



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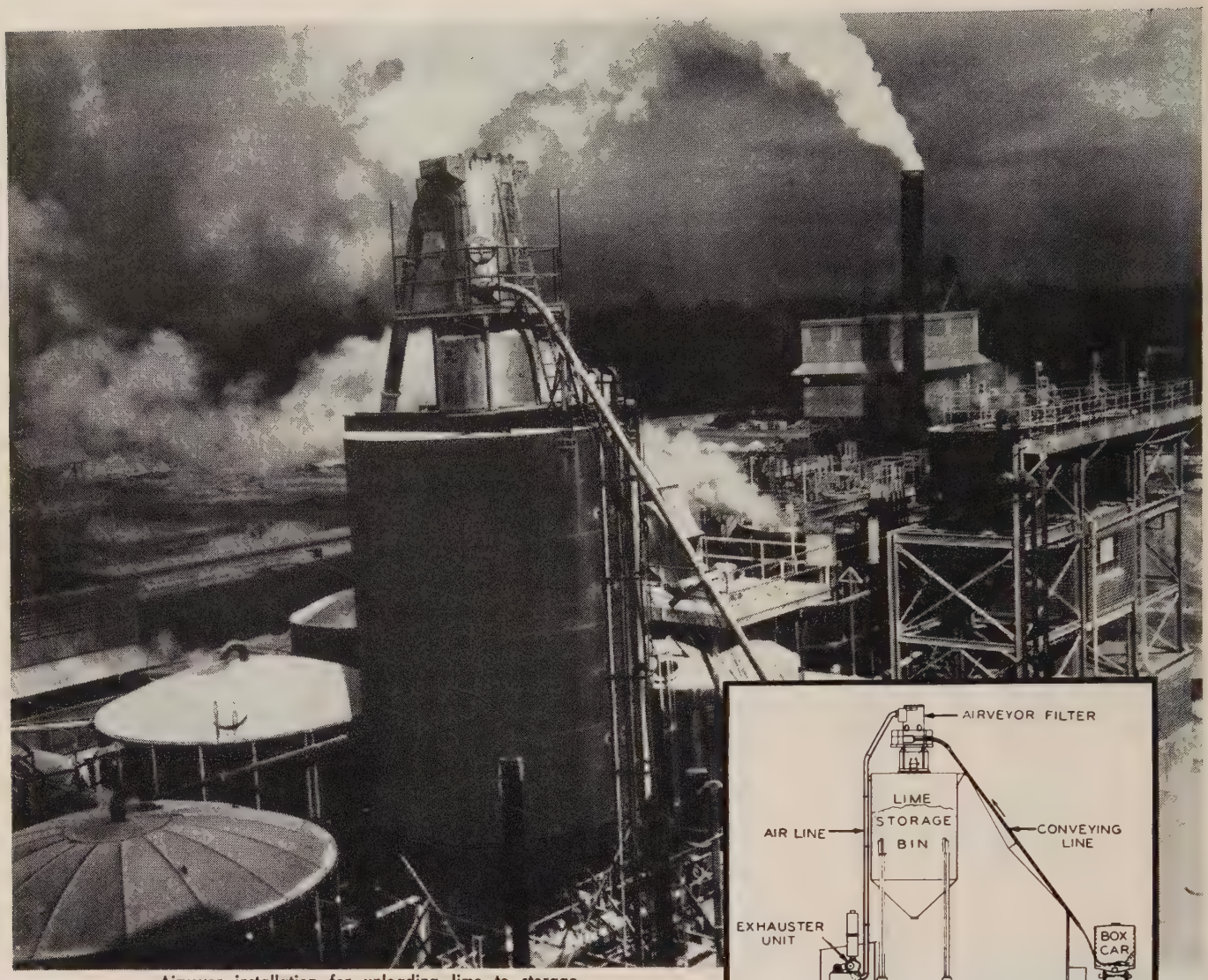

Airveyor installation for unloading lime to storage for re-causticizing system. Right: layout of the system.

Paper profits come with The AIRVEYOR® *at* RIEGEL PAPER MILLS

Profits in paper-making are on the rise at Riegel-Carolina Paper Mills, Acme, N. C. because Fuller Airveyors are cutting handling costs to the core.

This new 200-ton pulp mill is equipped with Airveyors for the bulk handling of process chemicals.

Fuller CONVEYS BY AIR . . . NOTHING MOVES BUT THE MATERIAL

3 Airveyors are in use:

1. Unloading pebble lime for delivery to re-causticizing system as illustrated. (Handles 10 tons per hour.)
2. Unloading pebble lime and soda ash from cars for delivery to storage. (Handles 7½ tons per hour.)
3. Unloading salt cake from storage and reclaiming from storage for delivery to the mix-tank in the Kraft mill recovery building. (Handles 7½ tons per hour.)

An increasing number of important pulp and paper mills in all producing areas are finding new savings in Fuller Airveyor systems in handling raw paper-making materials. Each Airveyor installation is custom-tailored to fit specific handling requirements, determined in advance by Fuller engineers. Such service is yours without cost—may be an important factor in finding new cost savings. Write today for complete information.

FULLER COMPANY,
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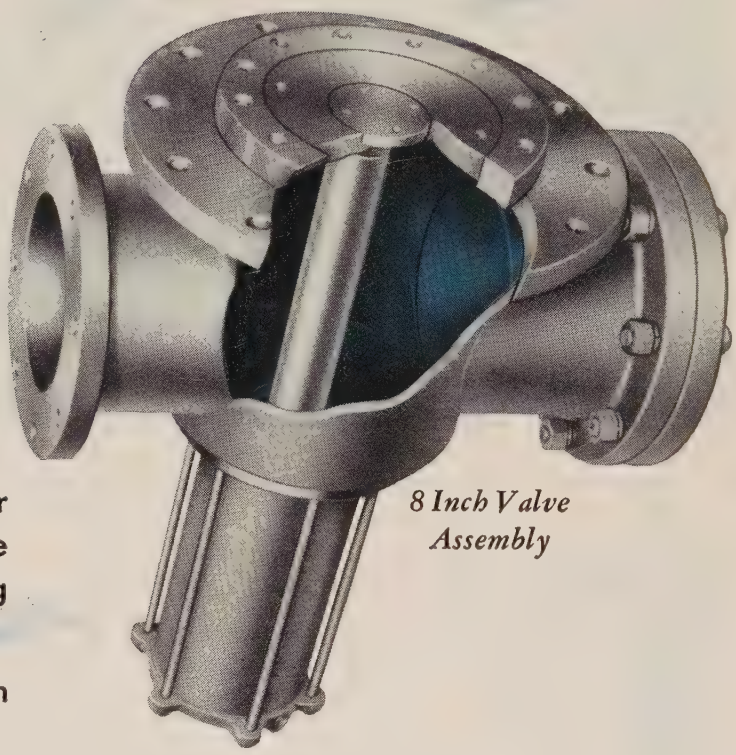
Dry Materials Conveying Systems and Coolers • Compressors and Vacuum Pumps • Feeders and Associated Equipment

RICE BARTON

Dump Valves



8 Inch Valve Assembly

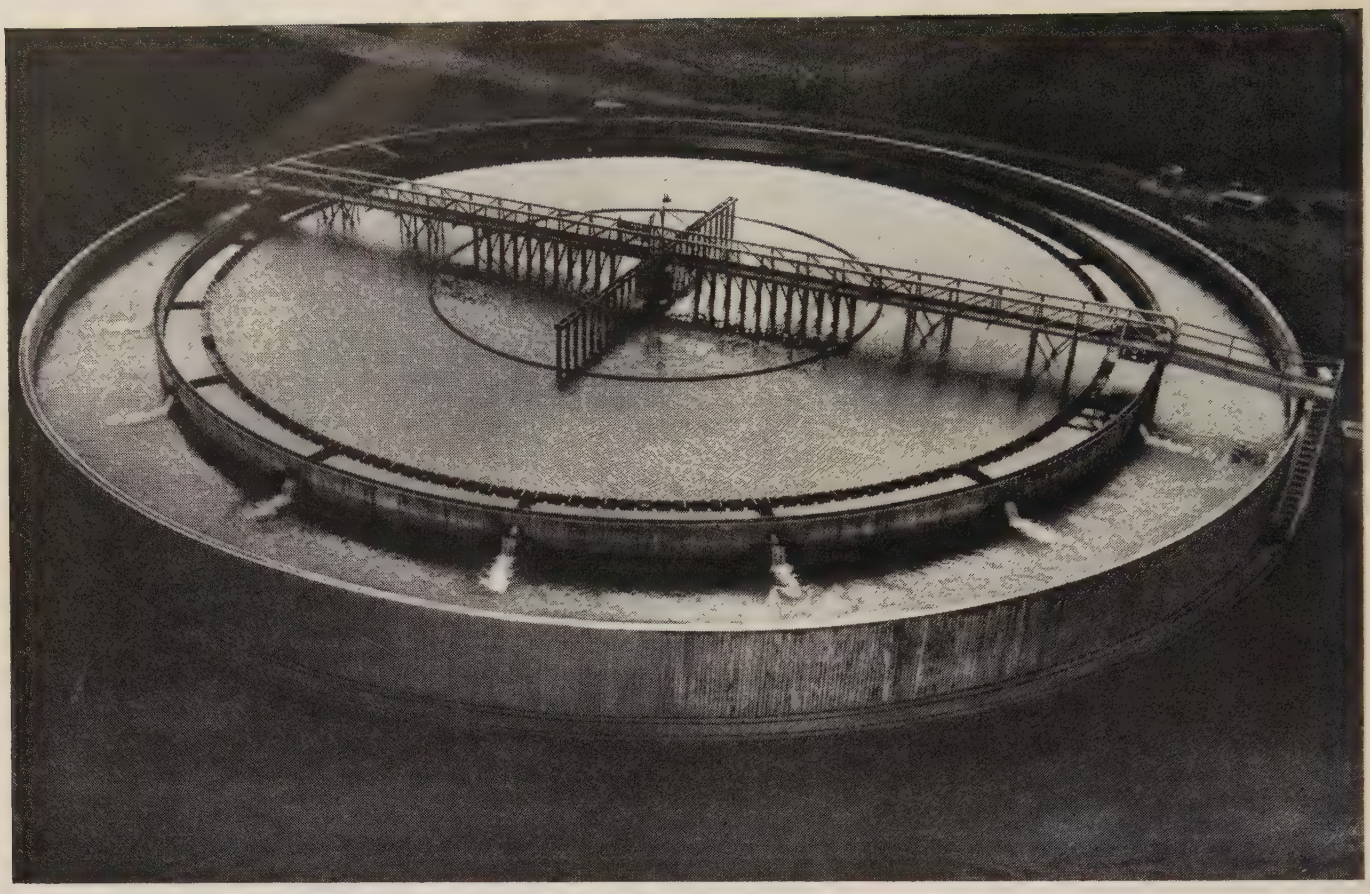
Answering a need for a superior dump valve for the paper industry, Rice Barton Dump Valves have the following advantages:

- Passages of valve are clear, smooth and unobstructed.
- Plug type flange used to eliminate any stock accumulation in valve.
- Gate of valve flush with floor of tank which prevents unpulped stock from pocketing above valve.
- Valve may be opened and closed from a remote location handy to operator.
- Either water or compressed air may be used for actuating valve.
- Discharge in any direction by swinging valve on bolt holes.

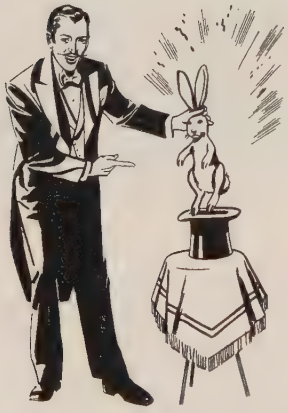
Construction — Valve body available in either cast iron or bronze.
Trim of bronze or stainless steel.

RBR 8-53

RICE BARTON Research Corporation
WORCESTER 1, MASS.



Located at Fibreboard Products, Inc., Antioch, Calif., this Clariflocculator treats 14 MGD of San Joaquin River water for process use. A 15′ wide annular storage reservoir surrounds the 150′ dia. Clariflocculator and a Dorrco VM Pump removes the dense underflow at minimum water loss.



No "Magic Formula" Approach Here...

Supplying 14 MGD of clear, process water for a West Coast Pulp Mill called for more than a "magic formula." Like all well-designed water treatment plants, it called for a detailed analysis of the problem. Raw water composition, rate of flow, results required, and local conditions were all studied before selecting the type of treatment to be used. The most efficient answer in this case was combination treatment with a Dorrco Clariflocculator.

There is no magic formula for every type of water treatment problem . . . no single equipment unit that will give ideal results under all conditions. For a brief picture of the complete Dorr equipment line for both conventional and high-rate treatment, write for Bulletin #9141, The Dorr Company, Stamford, Conn.

Clariflocculator is a trademark of The Dorr Company, Reg. U. S. Pat. off.

Every day nearly 8 billion gallons of water are treated by DORR equipment

Better tools TODAY to meet tomorrow's demand

DORRCO

DORR

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THE DORR COMPANY • ENGINEERS • STAMFORD, CONN.

Offices, Associated Companies or Representatives in principal cities of the world.

DU PONT OFFERS YOU

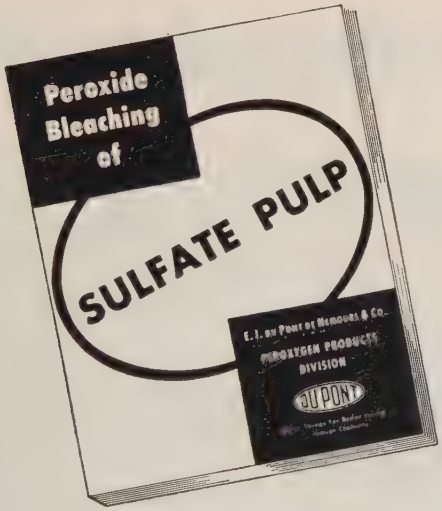
A NEW Peroxide Bleach Process for KRAFT

NOW you can bleach Sulfate pulp to a HIGHER BRIGHTNESS . . .

WITH EXCELLENT STRENGTH CHARACTERISTICS

The *new* Du Pont peroxide bleaching process is an easy, economical way to produce high-brightness sulfate pulp with no undue loss in strength. The process is easily installed and in most cases *needs no major changes in your present installation!*

Details on how this *new* peroxide bleaching process can improve the brightness of your sulfate pulp—including installation, sequence of operations, bleaching formulas, chemical control tests, etc.—are presented in a new Du Pont booklet. To get this booklet, send in the coupon below.



Technical advice and assistance are available from Du Pont specialists who have worked intimately with the development of this new peroxide bleaching process. Let them show you how you can solve your "high-brightness kraft" problem this new, economical way. Write to: E. I. du Pont de Nemours & Co. (Inc.), Electrochemicals Department, Peroxygen Products Division, Wilmington 98, Delaware.

SEND FOR YOUR COPY OF THIS BOOKLET

DU PONT
PEROXIDES
FOR WOOD PULP BLEACHING

"Albone".....Hydrogen Peroxide
"Solozone"..... Sodium Peroxide

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

E. I. du Pont de Nemours & Co. (Inc.)
Electrochemicals Dept., Peroxygen Products Div.
Wilmington 98, Delaware.

Please send me my free copy of "Peroxide Bleaching of Sulfate Pulp."

*Name*_____ *Position*_____

*Firm*_____

*Street & No.*_____

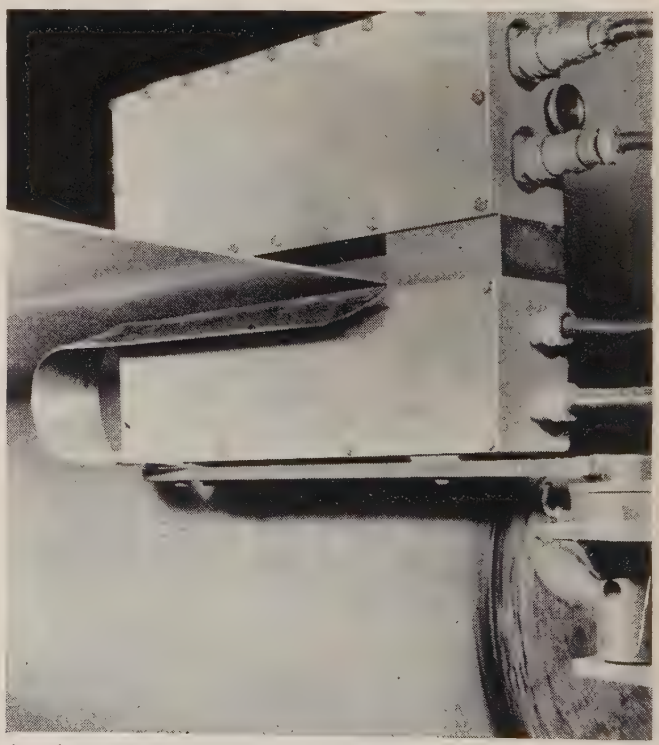
*City*_____ *State*_____

OPERATION—fast, convenient. At Fibreboard, G-E sectional drives keep machines at maximum production—maintain draws accurately, respond to adjustment quickly.

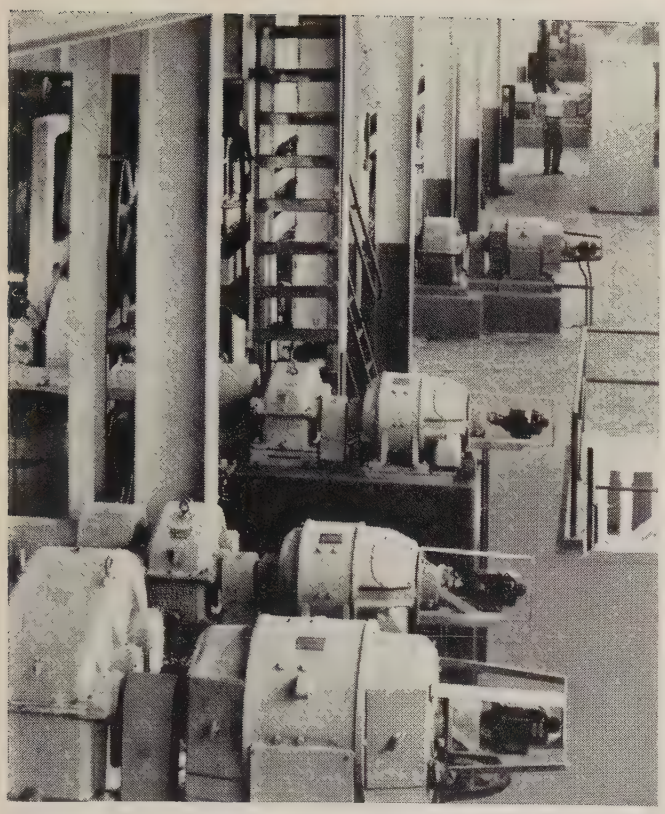
MAINTENANCE—machine outages reduced. For co-ordinated maintenance, sections can be operated independently or together. Components are reliable, need only routine attention.

Drive flexibility at Fibreboard helps

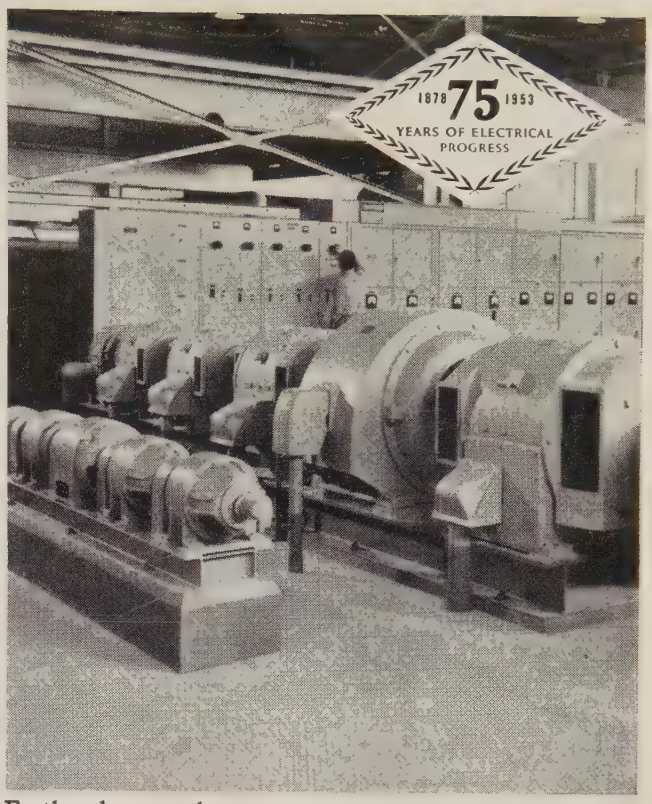
ADAPTABILITY—meets changing operating techniques. A G-E paper tensiometer like this was readily installed to control paper tension automatically at Fibreboard.



Another new production equipment at Fibreboard is the General Electric beta-ray gage, above. It measures paper basis weight continuously without touching the sheet.



INSTALLATION—costs less, takes less space. G-E sectional drives make back side of machines more accessible—provide for more efficient machine operation and maintenance.



Further, because the motor-generator sets and compact G-E control (above) are located away from the machines, valuable production-area floor space is saved.

keep output and quality high

Low installed costs, high production continuity, increased paper-machine adaptability provided by two G-E multiple-generator sectional drives

Fibreboard Products Inc. produces board in their mill at Antioch, Cal., on a cylinder machine and a Fourdrinier machine, both equipped with General Electric multiple-generator sectional drives.
Here is what Fibreboard says:

1. Installation was less expensive. Compact G-E drives went into place easily, quickly—made back sides of machines more accessible. To save floor space, motor-generator sets and control were located away from machines. Result: lower installed costs.

2. Operation is convenient, precise. Precise draw and quick slack take-up control mean quick, accurate machine adjustment. Fast, regenerative braking and reversing, and smooth, fast starts reduce lost time due to grade changes, breaks, etc. Section ammeters give visual check for many paper-making variables. Result: increased high-quality production.

3. Machine downtime for maintenance is reduced. Routine maintenance for felt and wire changes is speeded—any section can be operated independently. Preventive maintenance techniques are used during routine shutdowns, since section ammeters often indicate mechanical difficulties before they arise. Result: greater production continuity.

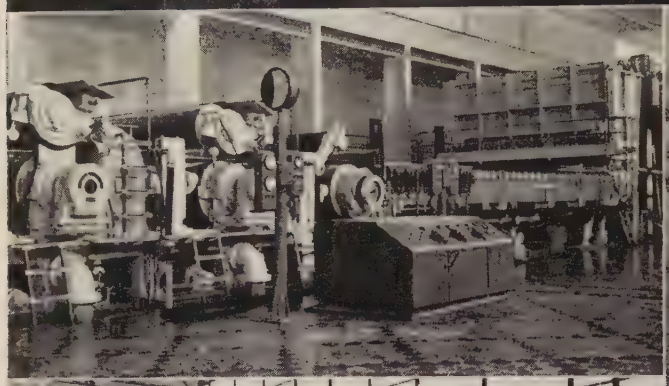
4. Drives keep pace with growth. Because of the inherent adaptability of G-E drives, future machine changes or re-arrangement can be made at minimum investment. New production equipments like the tensiometer and draw indicator can be readily applied. Result: flexibility to meet changing markets.

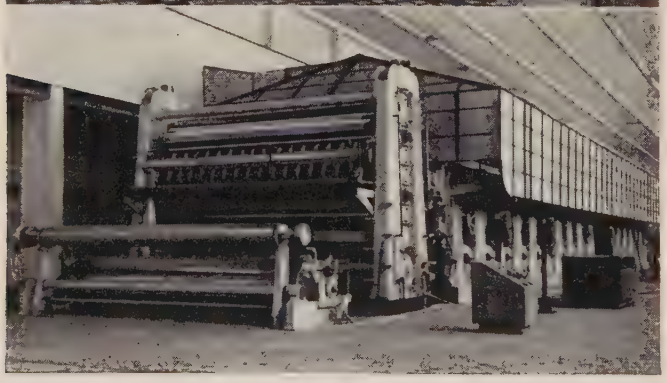
Contact your G-E sales engineer at the nearest G-E Apparatus Sales Office for more data on getting the same improved performance from your paper machines. General Electric Company, Schenectady 5, N. Y.

655-13

Engineered Electrical Systems for Paper Mills

GENERAL ELECTRIC





This is the most recent of Bagley & Sewall productions, designed, built and installed for the Murztaler Holzstoff-und-Papier-Fabriks A. G. in the city of Bruck/Mur, Austria, one of Europe's finest and most modern paper mills.

This fourdrinier machine has a wire width of 226 inches and length of 100 feet. Outstanding in design features, from the remote control system to the many engineering innovations throughout the various machine sections, it is one of the most modern papermaking machines in the world, today. Another B & S paper machine designed for efficient and economical manufacture of paper.

International recognition and acceptance of Bagley & Sewall resourceful engineering and precision built papermaking machinery is evidenced by the many installations in leading mills throughout the world.

100th ANNIVERSARY 1853 1953

designing and building paper making machinery

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NOW—get a helping hand on FOAM PROBLEMS...

from MERSIZE

High sizing efficiency combined with low foaming

—another Monsanto "first"!

Here's real sizing news—and another Mersize "first" that merits the most critical comparison with rosin size and with fortified sizes.

The "foam index" of Mersize has been lowered drastically—a development which now gives you *all* the advantages of fortified size *without* the troubles resulting from foam.

Mill tests show that new, low-foaming Mersize will provide significant improvement in foam conditions right down the line—from the beater—to the machine—to foam spots in the paper. And, with the viscosity of Mersize also lowered, you have two good reasons for trying *new* Mersize in *your* mill, under your own production conditions. MONSANTO CHEMICAL COMPANY, Merrimac Division, Boston 49, Mass.

MONSANTO

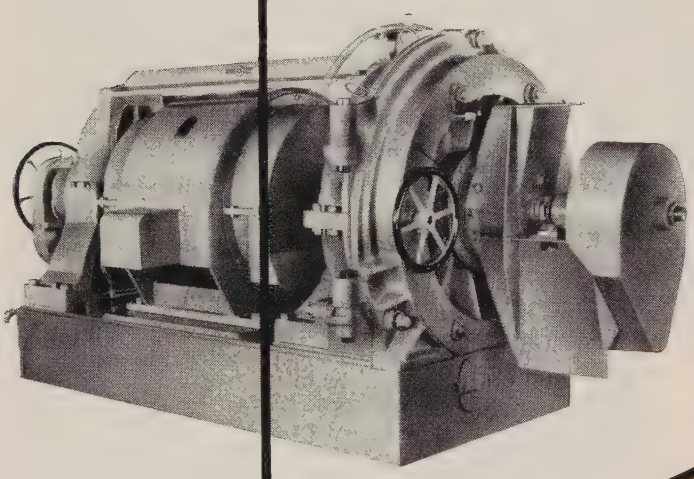
SERVING INDUSTRY . . . WHICH SERVES MANKIND

Mersize: Reg. U. S. Pat. Off.

Q. how to make **more profits** in pulp refining

A. with "SPROUT"

for that pulping problem
GET A SPROUT!



here's why: Sprout-Waldron Refiners are chosen by *most* mills for all types of pulping and refining operations. They are the *leading producers* of semi-chemical pulp. For economical pulping and refining, choose a Sprout!

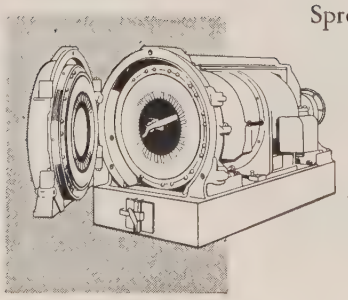
* high pulp quality
* high capacity
* flexible operation
* rugged construction

Is this Your Refining Problem?

- SEMI-CHEMICAL PULPING, unbleached and bleachable pulps, all grades from corrugating board to newsprint and bond paper
- High Yield Kraft Pulping (Brown Stock Refining)
- Kraft and Sulphite Knotter and Fine Screen Rejects
- Groundwood Screen Rejects
- Bagasse and Straw Pulping, for unbleached and bleachable pulps
- Insulation Board Fiber Preparation
- Hardboard Fiber Preparation
- Flooring Felt Fiber Preparation
- Waste Paper Stock Preparation

For careful analysis and specific recommendations, send your pulping problems to Sprout-Waldron. Address: Sprout-Waldron & Co., Inc., 38 Logan St., Muncy, Pa.

S W



SPROUT-WALDRON
PULP REFINERS

273

Nalco #71

PAPER MILL ANTIFOAM

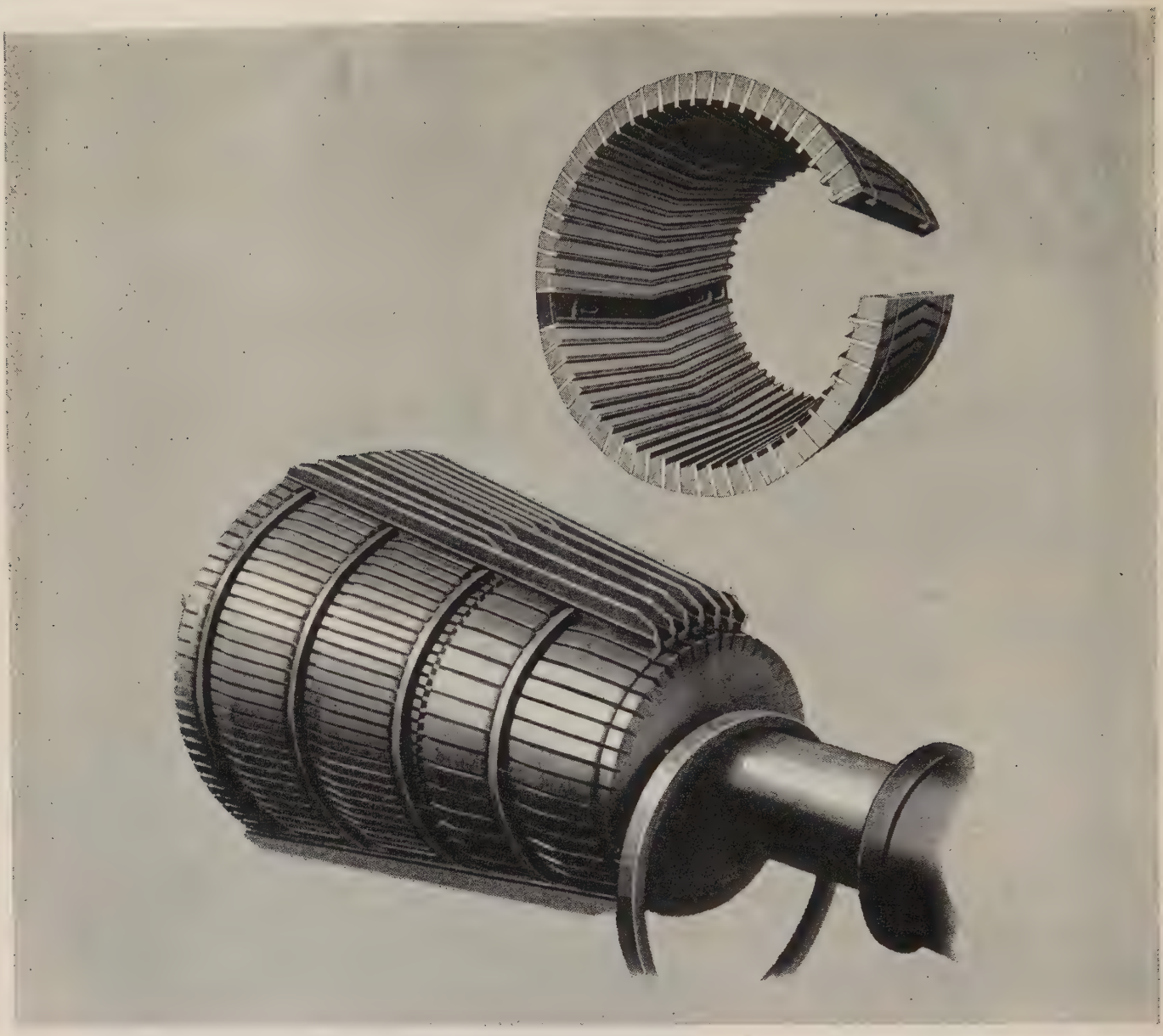
- **CONTROLS** foam and bubble formation over wide pH range—4.0 to 9.5!
- **ELIMINATES** bubble formation on wires.
- **EASY** to mix and feed.
- **NO EFFECT** on other materials in the furnish.
- **ECONOMICAL**—Average cost less than 15¢ PER TON of paper produced.

NALCO 71 not only positively eliminates foam and bubble formation in paper machine systems without affecting the furnish, but it also *stays in the water.* This means that remarkably small dosages of 71 efficiently prevent foam overflows, wadding, uneven caliper and other foam difficulties. Churning of Jordans, action of stock pumps and the flow of stock—the very things that cause foaming in untreated systems—all promote better action of Nalco 71!

Complete information on Nalco 71—and on other Nalco Chemicals for paper manufacturing use will be furnished upon request. Write today for prompt action on a permanent solution for your foaming problems.

NATIONAL ALUMINATE CORPORATION
6197 West 66th Place
Chicago 38, Illinois
Canadian inquiries should be addressed to Alchem Limited, Burlington, Ontario, Canada

THE Nalco SYSTEM
Serving the Paper Industry through Practical Applied Science



Really Rugged

Way back when today's Superintendents were just broke hustlers Bulldog filling was the big sensation in the filling field. It was the first preassembled filling ever built. And because Bulldog is the most rugged shell filling that ever went into a jordan, it still leads.

The same rugged strength is also present in the Shartle X66 plug.

By the way—how about sending us templates for file, and later use in an emergency. Scores of mills have already done so!

BLACK-CLAWSON

SHARTLE BROS. MACHINE DIVISION • MIDDLETOWN, OHIO

"Buffalo"

Fan Features that Reduce DRAFT Costs

1. STRENGTH

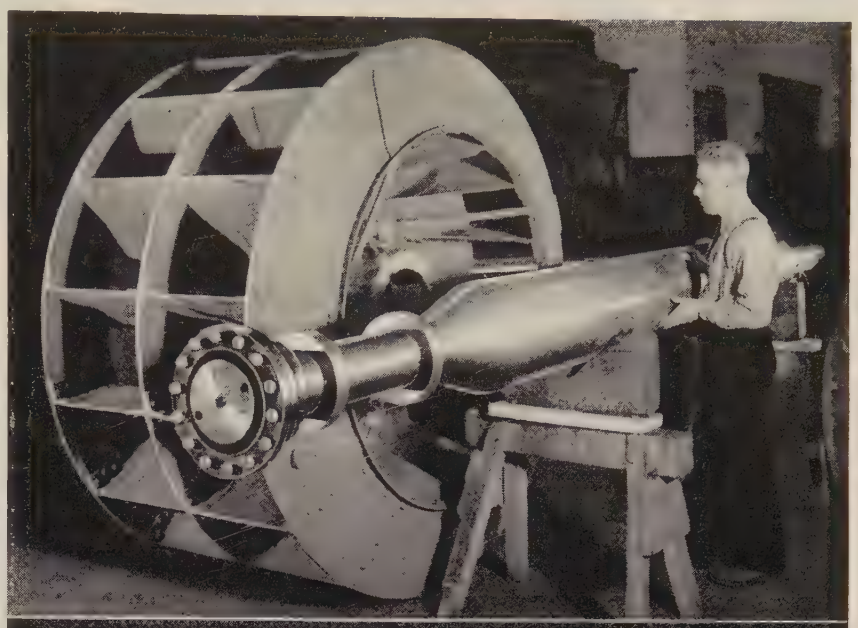
In such severe service as mechanical draft, the "cheapest" fan is the one that lasts longest. "Buffalo" Fans are built for the longest possible life. Note the heavy, rigid construction of the "Buffalo" rotor shown at right, and the oversized shaft turned from one solid steel forging, thrust collars and all. This is typical of the strength and endurance built into every "Buffalo" Draft Fan—strength that means far less repair and replacement cost through added years of service.

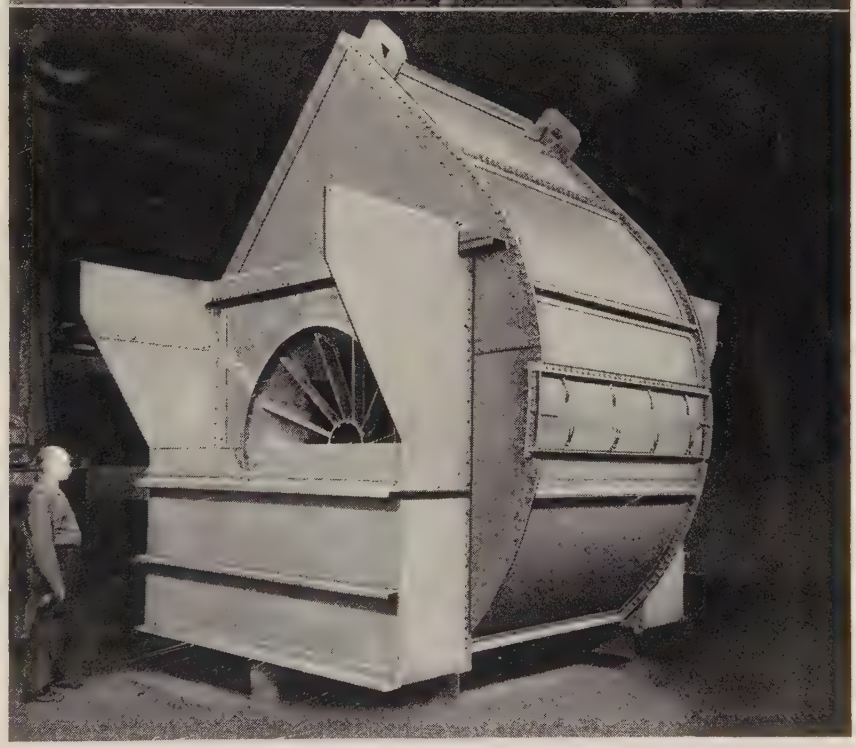
2. ENGINEERING

"Buffalo" Engineering "know-how" is back of the high efficiency and favorable pressure characteristics of "Buffalo" Forced Draft, Induced Draft and Primary Air Fans. These characteristics mean stable delivery over widely varying fuel requirements—minimum erosive action on Induced Draft — minimum driving power on all fans.

3. SERVICEABILITY

Accessibility of all parts is a "must" if servicing is to be done rapidly and economically. At right is a "Buffalo" Induced Draft housing, showing the sectional, bolted design and access hatch. Cleaning, coating, rotor balancing—even rotor removal—are greatly simplified. For further features that give you lower draft costs —plus more dependable draft—write today for Bulletin 3750.





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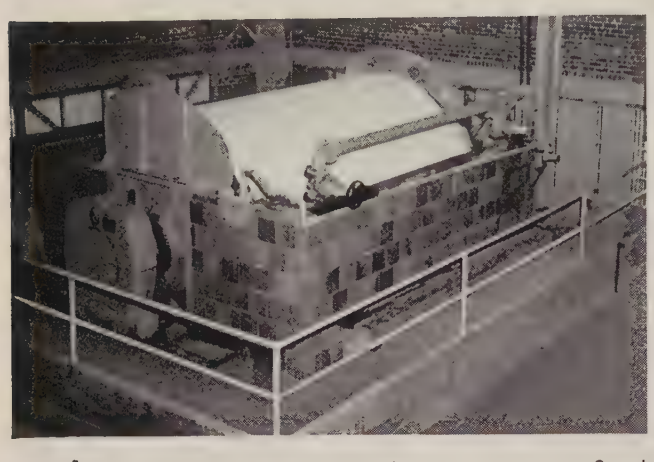
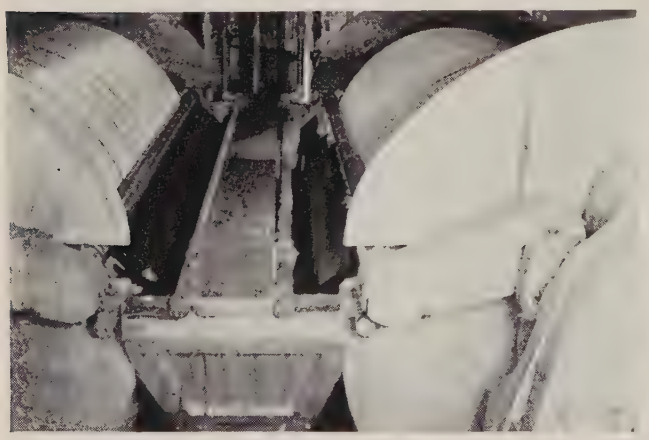
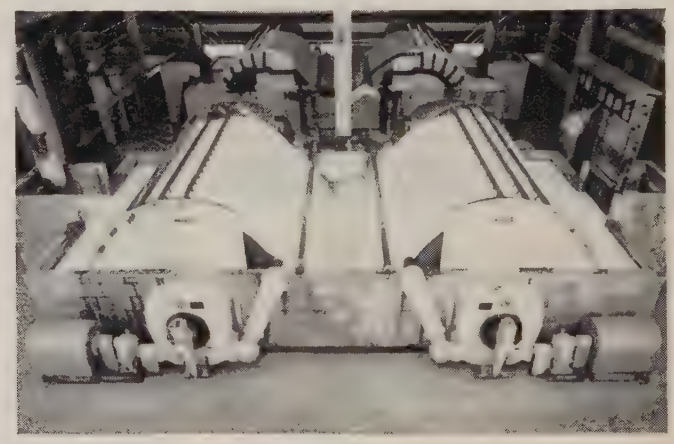
Widest Type Selectivity* Assures the Best for

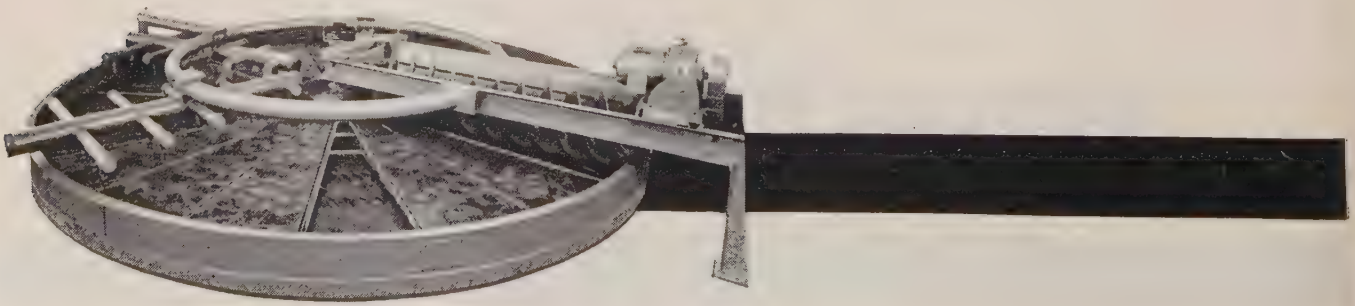


*At Oliver United, for example, you are not confined to any one type Saveall. We can offer either the Oliver Drum Type or the American Disc Type Saveall, each of which has its *outstanding advantages* depending on your individual requirements.



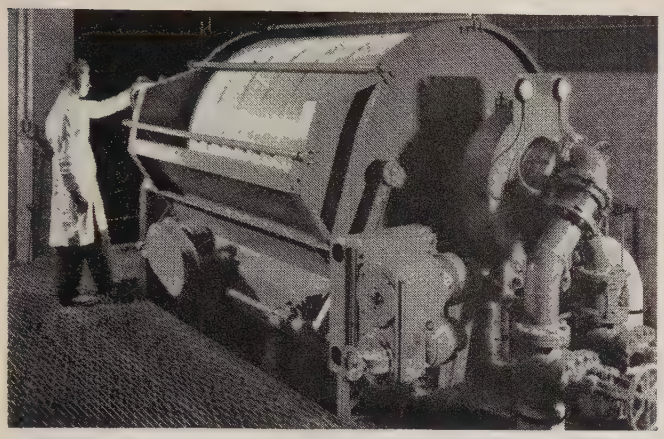


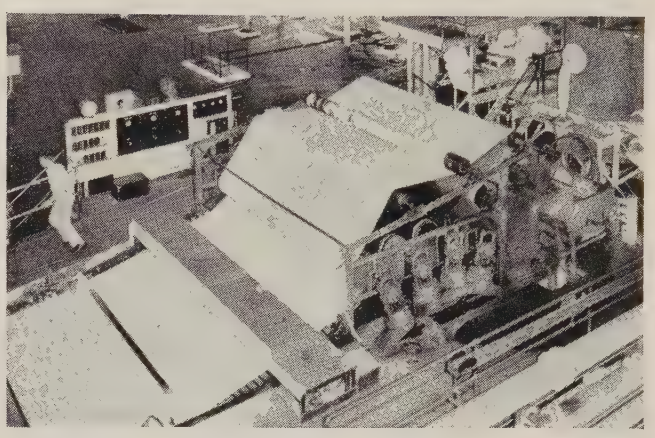
*Or take pulp washers. You have a choice of the pipe type drum filter known as the Oliver Pulp Washer or the washer with the centrally located "ring valve," known as the Oliver Ringvalve Washer. And we also have the Oliver Horizontal Filter which *has the great advantage of multiple countercurrent washing on one unit. This is a new development which reduces dilution and improves washing especially when handling extremely free fiber difficult to handle on a drum type washer.*



UNITED

Your Pulp Filtration and Washing Requirements





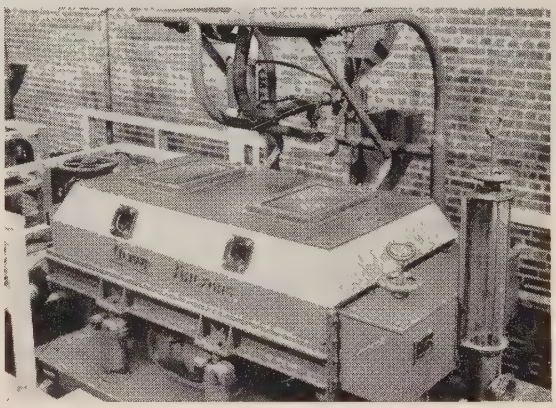
✱ Our Lime Mud Filter is an adaptation of the widely used Oliver Chemical Filter. Handling lime mud is not a pulp-handling problem. It's solely chemical in *all* its aspects. It's not a sheet that is discharged from the filter but a thick cake, which removes practically all of the fine solids from the filtrate recirculated to the causticizing system, and thus improves thickener operation.

✱ The Oliver Board Forming Machine is especially designed to form the strongest, most uniform, board of the desired weight from a wide variety of pulps.

Thirty (30) such units have and are giving satisfied users the best possible performance and production.

Oliver Forming Machines are geared to operate up to 60' per minute, thus providing for potential capacity of over 1,000,000 square feet of ½" board per day. Oliver maintenance costs are lower.

Back of this array of Olivers for the Pulp and Paper Industry is the experience gained since the early 20's when Oliver pioneered and developed the use of vacuum filters in this industry.



We are continuing pioneering and development in the pulp and paper industry because we appreciate the great future for this industry.

In this connection we now have the Oliver-Ahlfors Upflow Pulp Screen. A really excellent efficient new type screen. Write for Bulletin No. 750.

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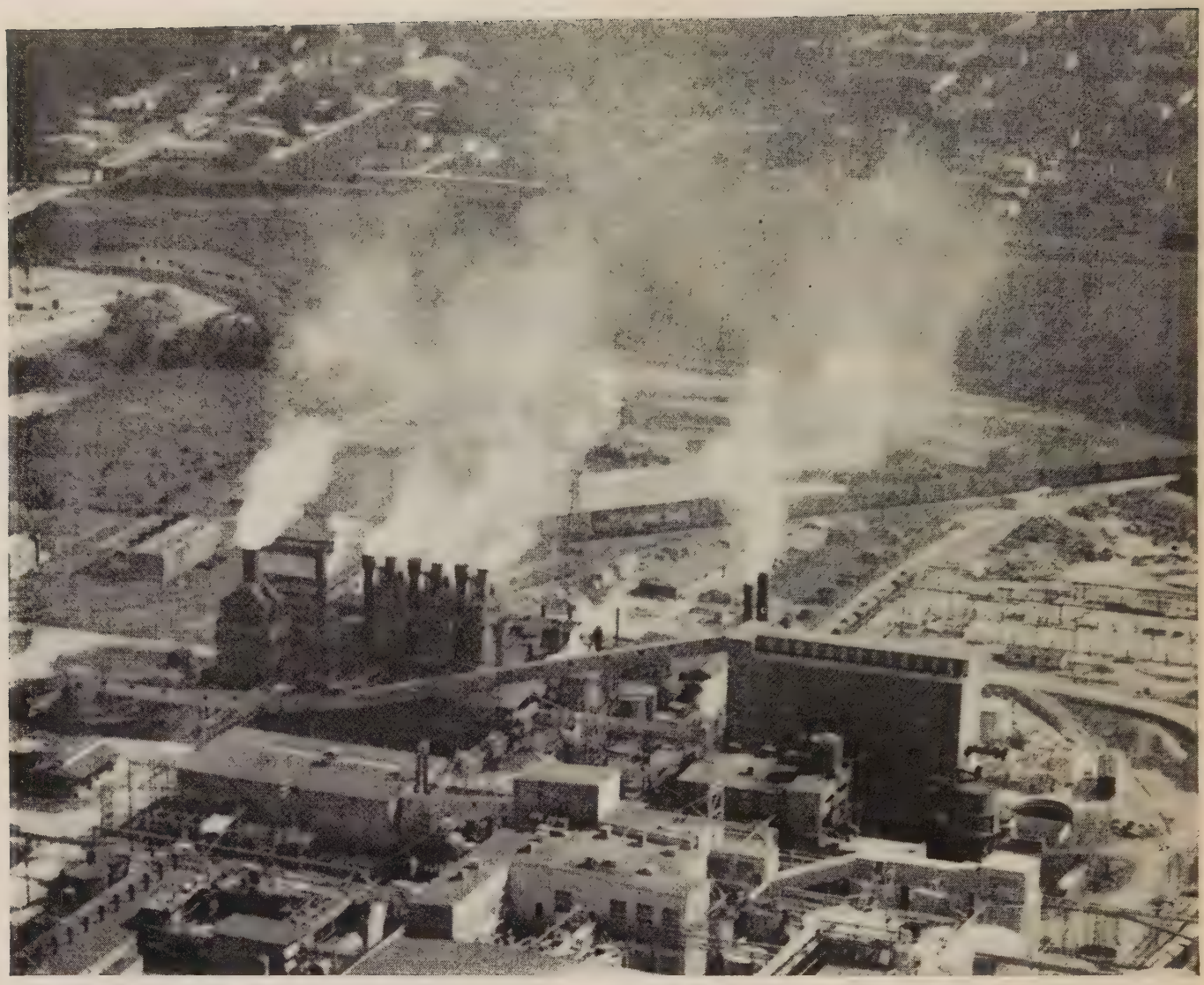

There's good will in the air

. . . when your odor abatement program is really effective

Even at the most modern pulp mills, escaping sulfide odors continue to be a major problem. Condensing, scrubbing, or burning the waste gases have not been the complete solution to effective odor abatement—odor abatement that literally means "good will in the air."

Du Pont chemists and engineers, who have worked closely with management, engineers, and production men at most of the country's leading pulp mills, turned their attention to helping them work out their waste gas odor problems. As a result of these experiences, specially engineered odor-masking compounds—Du Pont "ALAMASK" odor-masking compounds—were developed.

In actual mill operations, the use of "ALAMASK" has effectively reduced the noticeable malodors. As these operations continue, priceless good will is being built for the mills with their communities and with their employees.

Perhaps Du Pont "ALAMASK" odor-masking compounds, combined with Du Pont experience in the pulp and paper industry, can be the answer to your odor abatement problem. For information and technical service, write to E. I. du Pont de Nemours & Co. (Inc.), Organic Chemicals Department, Wilmington, Delaware.

Du Pont **Alamask**

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Odor-Masking Compounds

DU PONT

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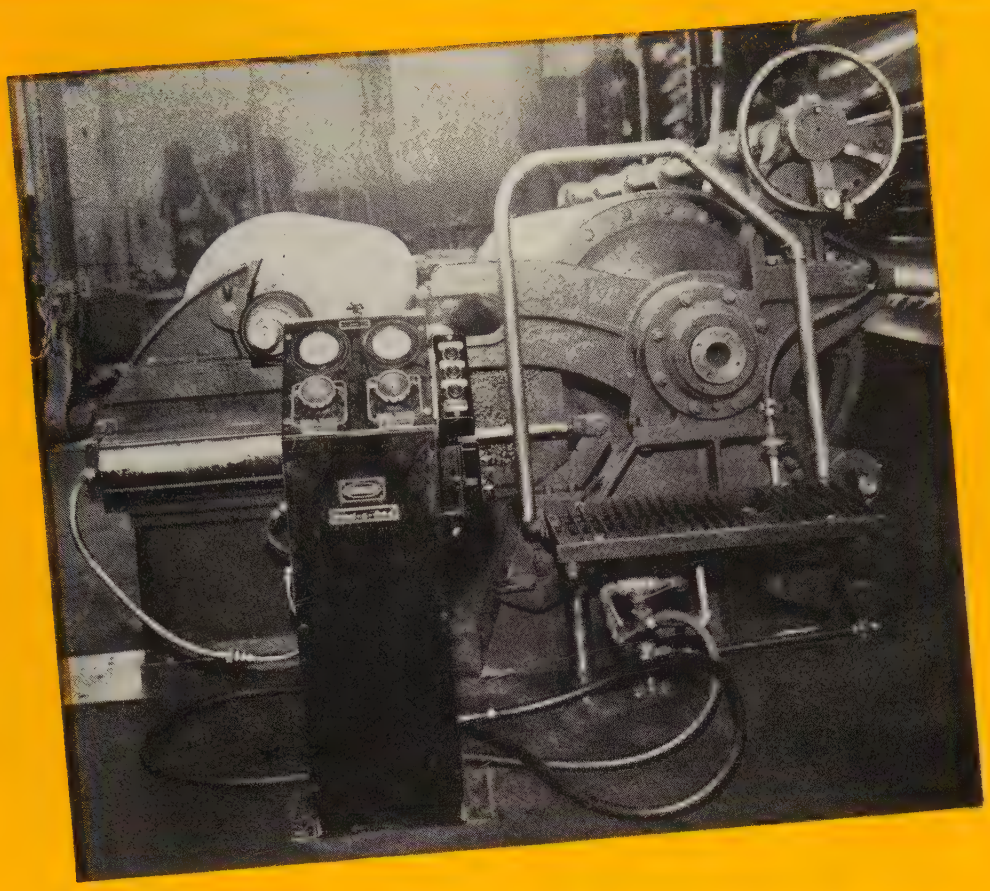
... THROUGH CHEMISTRY



Modernize with a NEW Puseyjones Reel...

Since the introduction of the Puseyjones Improved Type Uniform Speed Reel several years ago, numerous installations have been made in connection with new machines and to replace obsolete equipment on existing machines.

In many instances, the satisfactory performance of a new Puseyjones Reel has resulted in subsequent orders from the same mill.

An outstanding feature of this Puseyjones unit is the pneumatic adjustable loading mechanism which greatly simplifies reel changes and gives added safety to the operation. There's no loss of valuable production time. Operation is at constant paper speed. Controlled tension and accurate roll-to-drum pressure results in uniform rolls. Smoother winding and ease of operation are additional features.

Find out how a Puseyjones Improved Type Uniform Speed Reel can improve your production and give you more uniform paper rolls for better profits. Write us today — we will have our District Representative call.

THE PUSEY AND JONES CORPORATION
Established 1848. Builders of Paper-Making Machinery

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Wilmington 99, Delaware, U.S.A.

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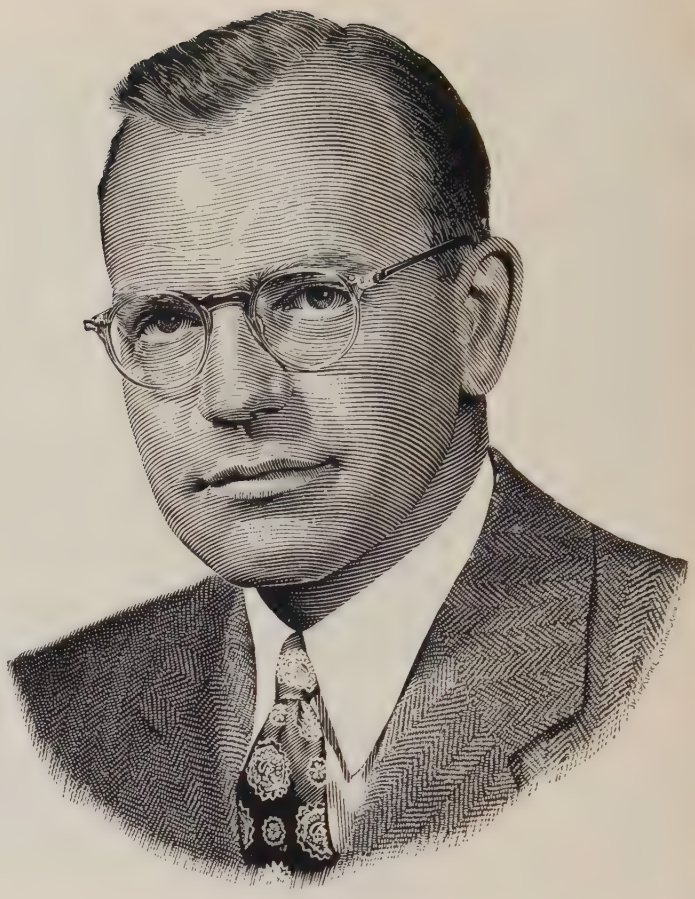
"National security is impossible without financial security of individual citizens..."



FRED MAYTAG
The Maytag Company

"Ingenious research and the ability to produce... which have helped to make the United States the world's greatest nation... could not have been realized without the savings of millions of thrifty persons. Savings of individuals financed new inventions, developed others. The Payroll Savings Plan for purchasing Savings Bonds regularly provides an easier way for American workers to save for future spending or investment, for their own security, and for their nation's security. Our experience at the Maytag Company has shown us that a successful Payroll Savings program can be the foundation and the cornerstone of happy employee relations."

Let's point up Mr. Maytag's concise summary of the Payroll Savings Plan with a few very recent figures:

• at the close of February, 1953, the *cash value* of Series E Bonds held by *individuals* reached a new high: $35.5 billion. This is $1 billion more than the value of the Bonds held on May 1, 1951, when E Bonds began to mature.

• to this encouraging reservoir of future purchasing power, 8,000,000 Payroll Savers are adding $160,000,000 per month by their consistent investment in U.S. Savings Bonds.

• unit sales of E Bonds in 1952 reached the highest level of the past six years—more than 77 million individual pieces. Of the 77 million units, 67 million were in the $25 and $50 denominations—the bonds bought chiefly by Payroll Savers.

• Payroll Savers are serious savers—of the approximately $6 billion Series E Bonds which had become due up to the end of March, $4.5 billion, or 75%, were retained by their owners beyond maturity.

If you are not among the 45,000 companies that make the benefits of the Payroll Savings Plan available to their employees . . . or if you do have a Plan and your employee participation is less than 50%, a telegram or letter to Savings Bond Division, U.S. Treasury Department, Washington Building, Washington, D. C., will bring you all the information and assistance needed to build a *good* Payroll Savings Plan.

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better resistance to liquids with ALWAX* or WAXINE® Sizes

"Seal up" your papers with the dependable liquid resistance of ALWAX or WAXINE sizes . . . and you seal up your paper sales!

You'll find ALWAX and WAXINE sizes give your papers *uniform, dependable* resistance to water, lactic acid, blood serum and ink.

You'll discover, too, that your papers fold better...your boards bend better . . . with ALWAX or WAXINE sizes.

And you'll find an unusually wide range of sizes to choose from, each one specially developed to give excellent results in the beater, size tub or calender box—all maintaining good stability in storage.

If wax-sizing can do it, an ALWAX or WAXINE size can do it best! Just ask a Cyanamid Technical Service man to recommend the type best suited to your requirements.

Cyanamid Paper Chemicals: ACCOBRITE® Rosin Size • ACCOCEL® Dispersants AEROSIZE® Sizing Emulsions • AEROSOL® Wetting Agents • ALWAX* and WAXINE® Wax Sizes • AZITE® 900 Liquefier • CALMICRO® Calcium Carbonate • CYFOR® Rosin Sizes • CYNOL* Rewetting and Softening Agents CYRON* Synthetic Size • PAREZ® Wet-Strength Resins • Rosin Size—Liquid and Dry • Aluminum Sulfate • Sodium Phospho Aluminate • Clays • Defoamers and other Specialty Products • Acids • Alkalis • Other Heavy Chemicals *Trademark

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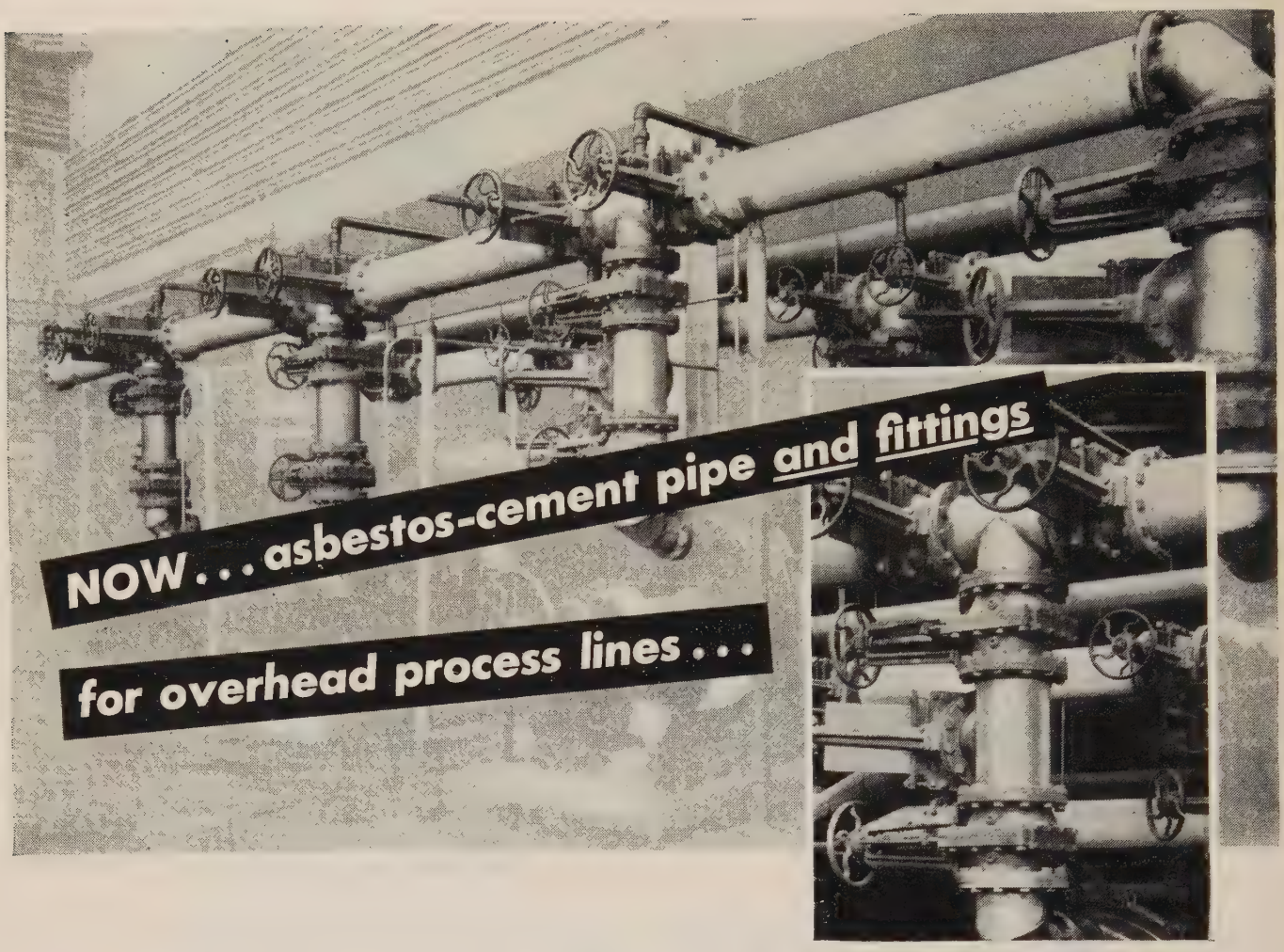

Transite Pressure Pipe provides high carrying capacity and economical, efficient service...

You can now obtain Transite* asbestos-cement Pressure Pipe with Transite-lined Streed Fittings for your overhead process systems. This permits the installation of high strength non-metallic pipe for handling raw and treated water, washed and unwashed pulps, stocks of all kinds, multi-stage bleaching systems (except direct chlorination) and certain mill wastes. There is no better way to provide clean pulp and stock than by handling it through Transite Pressure Pipe.

Low installation costs—Transite is light in weight, easy to handle, and can be drilled, cut, threaded and machined with standard tools. *And*, because its carrying capacity stays high, you can specify the smallest diameter pipe necessary . . . thus making the minimum capital investment.

Low pumping costs—Transite Pressure Pipe offers exceptionally low frictional resistance to the flow of liquids (flow coefficient C=140 for water). Since it is resistant to sliming and bacterial growths, this high carrying capacity is continuously maintained so that pumps can be operated at maximum efficiency and lowest cost.

Low maintenance costs—Transite cannot rust and is highly resistant to the corrosive action of mild acids and alkalies. Consequently, it requires a minimum of maintenance throughout its long life.

For underground service too, such as water supply or fire lines, Transite Pressure Pipe offers the same outstanding advantages. To obtain further information on Transite Pipe Systems for paper mills, write Johns-Manville, Box 60, New York 16, N. Y.

*Reg. U. S. Pat. Off.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville TRANSITE PRESSURE PIPE

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Call SOLVAY FIRST

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for these Paper-Making Chemicals

Only Solvay offers you a specialized paper makers' Technical Service—a staff of highly skilled experts who are specialists in the paper field. These technicians are always at your service, ready to help with your problems.

And for prompt delivery service, Solvay has three centrally-located manufacturing plants... thirteen convenient branch sales offices... and a nation-wide chain of warehouses and stock points situated right in paper-making areas.

So when it's service you want, call *Solvay first* for these paper-making chemicals.

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Caustic Soda

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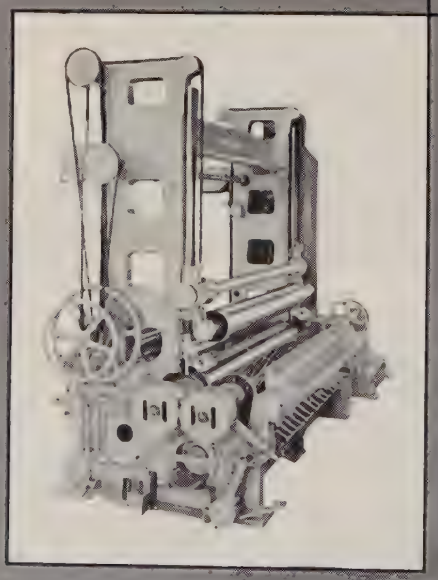

Wherever paper is processed; Mill, Finishing Room or Converting Plant — Langston Slitters & Winders give dependable, trouble-free service.

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Company
CAMDEN 4, NEW JERSEY

TRUE BLUE

rapid development with good fastness to light

purest shade of blue available

fast bond blue GDX

- clear, bright shade
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- especially recommended for

tints, medium and full shades of
blue and green for book, bond and cover papers

When an acid blue is required,
you can count on FAST BOND BLUE GDX.
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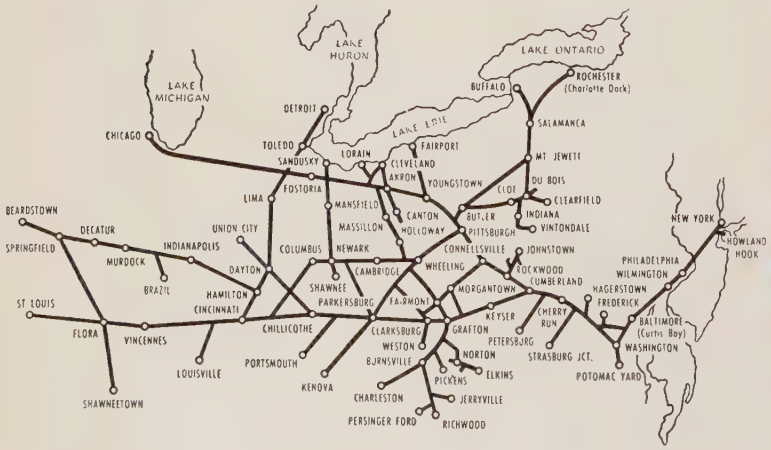
Whether your specific question concerns power, coking, steam, or space heating, you'll find the perfect answer among the wide variety of Bituminous coals in Baltimore & Ohio territory. Here lies an almost inexhaustible source of low-cost heat and energy.

The benefits of B&O Bituminous are many. Highly mechanized mines keep production costs low, size and quality uniform. Closeness to America's industrial heart means economical transportation. The ease of storing coal eliminates the need for expensive facilities. And new methods and devices take further advantage of the burning characteristics of Bituminous.

ASK OUR MAN! He will help you find the exact coal for your purpose, and explain the best way to burn it. You'll be amazed at the efficiency, economy, and cleanliness of B&O Bituminous today



BALTIMORE & OHIO RAILROAD

Bituminous Coals for Every Purpose

The Evaporation and Recovery of Ammonia-Base Waste Sulphite Liquor

L. C. JENNESS, R. E. DURST, and E. F. THODE

Heat transfer coefficients to ammonia-base waste sulphite liquor in an experimental, vertical, long tube, forced circulation evaporator have been determined. Variable velocities of liquor in the tubes and an approximately constant temperature driving force were employed. Concentrations ranged from 15 to 40% solids. The evaporator consisted of an 8-in. diameter steam chest surrounding three tubes 1 1/2 in. in diameter and 24 ft. long, surmounted by a vapor space. Liquor was recirculated from the vapor space to the tubes by means of a pump and water vapor was condensed in a spray condenser. Over-all heat transfer coefficients varied from about 150 to 300 B.t.u. per (hr.)(sq. ft.)(°F.) as the solids content of the liquor varied from 15 to 40% and as the linear velocity of liquor in the tubes varied from 1 to 5 f.p.s. Within the range of this investigation the size of the coefficient was directly proportional to the apparent velocity of liquor within the tubes and inversely proportional to the concentration of solids. The recovery of ammonia has been determined experimentally by the evaporation of mixtures of ammonia-base waste sulphite liquor and kraft waste liquor. The liquors were mixed in ratios of 1:1, 2:1, and 4:1 of kraft liquor to sulphite liquor previous to evaporation. The percentage of available ammonia recovered in the condensate from a surface condenser was found to vary from 60% to virtually complete recovery. No objectionable precipitation of solids or fouling of the tubes was observed. Serious pit corrosion of the stainless steel vapor space, particularly where clad to mild steel, was experienced during the evaporation of sulphite liquor alone.

AMMONIA-base sulphite cooking liquor has probably been in use commercially for at least 7 years. Several mills have recently converted from calcium-base sulphite to ammonia-base sulphite, or are considering doing so. The reasons for interest in the use of ammonia, in spite of its increased cost over calcium, appear to be the following:

1. It yields combined sulphur dioxide in a more soluble form than does calcium, and thus may permit a decrease of time for penetration in the cooking cycle.
2. LaFond and Holzer (*1*) state that it allows a shorter period of time for cooking to yield pulps of better quality.
3. It can be processed in the liquid state and thus obviate the necessity of crushing and grinding equipment.
4. It allows the formation of a soluble sulphate in waste liquors which should not cause scaling problems during evaporation as does calcium sulphate.
5. It should be more amenable to combustion in the form of concentrated waste liquor.

L. C. JENNESS, Professor and Head of the Dept. of Chemical Engineering; and R. E. DURST and E. F. THODE, Associate Professors of Chemical Engineering, University of Maine, Orono, Me.

The purpose of this paper is to present laboratory results on the evaporation of ammonia-base sulphite waste liquor and a possible method of recovering ammonia from it. The results were obtained by the use of pilot-plant equipment. Data on evaporation and recovery will be reported separately.

EVAPORATION

Equipment

The evaporator consisted of three vertical, stainless steel tubes 1 1/2 in. in diameter and 24 ft. long contained in a mild steel pipe of 8 in. diameter. Steam was admitted to the 8-in. pipe and liquor was circulated inside the three stainless steel tubes in parallel. The steam was surmounted by a vapor space which contained adequate baffles, a sight gage, and provision for recirculating liquor to the evaporator by means of a centrifugal pump. Vapor from the evaporator passed to a water-cooled spray condenser in which reduced pressure was maintained by means of a Nash Hytor. All surfaces in contact with the liquor and vapor were of type 316 stainless steel construction. The equipment in this form is described in detail by Dinsmore (*2*) a condensation of which description appears in *Paper Mill News* (*3*).

Previous to obtaining the results reported in this paper the vapor line to the condenser was enlarged and a rotameter was installed in the recycle line in order to control the volumetric rate of flow of liquor to the evaporator tubes. These alterations were made by L. P. Newton and D. G. Newton (*4*) and are reported in detail by them. A diagrammatic sketch of the evaporator, from the standpoint of its operation is shown in Fig. 1.

Procedure

The solution evaporated was ammonia-base waste sulphite liquor, obtained from a sulphite pulp mill, and contained approximately 10% solids. It was pumped to a head tank in Fig. 1, from which it was fed to the evaporator through a rotameter in the feed line. Liquor was recirculated from the vapor space through a rotameter and a pump to the bottom of the vertical tubes. Thick liquor was removed from the recirculation line by means of a valve previous to admixture of feed. Steam entered the top of the steam chest and steam condensate was removed from the bottom. Water that was evaporated passed from the vapor space to a spray condenser and thence to waste.

The primary objective was to evaluate heat transfer coefficients to liquor of various concentrations while flowing at various velocities through the tubes. In each determination, therefore, the evaporator was

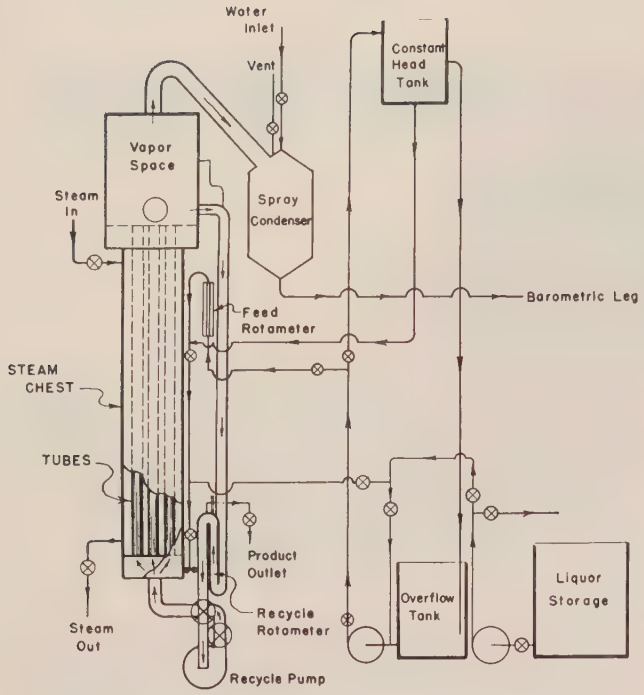


Fig. 1. Long tube pilot-plant evaporator

brought to a condition of steady state with continuous feed of about 10% waste liquor and removal of thick liquor of various strengths. It was then operated for a sufficient length of time to allow average measurements to be made of the following variables: rate of feed, rate of recirculation, rate of thick liquor removal, concentration of thick liquor, and the temperature of all liquid steams. The steam pressure was adjusted to maintain an approximately constant temperature difference between steam and liquor of about 40°F. in all of the data reported. This was accomplished by maintaining a pressure in the steam chest of about 27 cm. of mercury gage and pressures in the vapor space ranging from 30 to 35 cm. of vacuum.

Table I. Heat Transfer Coefficients

Run No.	*Solids, %*	*Linear velocity, f.p.s.*	*Temp. diff., °F.*	*Heat transfer, B.t.u./hr.*	*Heat transfer coeff., B.t.u./(hr.)(sq. ft.)(°F.)*
2	Water	3.60	44.5	397,000	313
3	Water	6.64	42.0	452,000	378
21	20	2.72	40.0	274,000	240
22	20	2.72	41.0	283,000	242
20	20	3.66	38.1	294,000	271
19	20	4.70	37.0	312,000	296
23	20	4.70	39.0	296,000	273
14	25	2.43	47.3	288,000	214
15	25	2.43	44.0	278,000	228
13	25	3.30	44.2	310,000	246
16	25	3.30	42.5	287,000	237
12	25	4.33	43.2	323,000	263
17	25	4.33	42.0	319,000	266
34	35	1.27	47.5	260,000	192
37	35	1.27	48.0	247,000	180
33	35	2.30	45.0	252,000	197
36	35	2.30	45.5	260,000	200
32	35	3.30	43.0	279,000	228
35	35	3.30	44.5	294,000	232
28	40	0.82	44.0	206,000	168
31	40	0.82	43.5	202,000	163
27	40	1.56	47.0	238,000	178
29	40	1.56	43.8	223,000	179
26	40	2.45	43.8	254,000	203
30	40	2.45	42.5	250,000	206

Results

After results were obtained on the rate of heat transfer to water, waste liquor was evaporated as described previously to yield thick liquor of 20, 25, 35, and 40% solids at various linear velocities of liquor in the tubes. Calculated data from these results are presented in Table I. In this table linear velocities of liquor in the tubes are superficial in that they are computed on the basis of volume of liquor to the bottom tube sheet and the cross-sectional area of the three tubes utilized. Actual velocities would, of course, be somewhat higher due to the formation of vapors.

Heat transfer coefficients in Table I are computed from the equation

$$q = UA\Delta t \qquad (1)$$

in which q is the amount of heat transferred in B.t.u. per hour, U is the heat transfer coefficient in B.t.u. per per square foot per degree Fahrenheit temperature difference, A is the heat transfer area of the outside surface of the tubes and tube sheet in contact with steam, and Δt is the mean temperature difference between that of steam in the chest and liquor in the tubes. Values for q and Δt are given in Table I. The amount of heat transfer area was 38.5 sq. ft.

The values for heat transferred presented in Table I and utilized in equation (1) are computed from the amount of steam condensed in the steam chest during each run. It is appreciated that these values are slightly larger than the amounts of heat transferred through the heating area on account of loss of some heat to the atmosphere. The steam chest was well insulated, however, and it was calculated that the maximum amount of heat loss from the steam chest was 6000 B.t.u. per hr. Since this figure is less than 3% of the amount of heat given up by the condensing steam these values of q were considered more reliable than those computed from heat balances due to the difficulty of getting accurate measurements of the various liquid and vapor streams.

Discussion of Results

The data presented in Table I are shown graphically in Fig. 2. As presented in Fig. 2 the results indicate that for a constant temperature driving force and thick liquor of a given concentration, the rate of heat transfer increases linearly with the velocity of liquor in the tubes throughout the range of these data. Also that the rate of increase is about the same regardless of the strength of liquor but that the rate of heat transfer decreases with increase of concentration of liquor.

The rate of decrease of heat transfer coefficient with increase of concentration of liquor is shown in Fig. 3. This figure was constructed by reading heat transfer coefficients from the lines drawn in Fig. 2 at constant linear velocities of 2 and 3 f.p.s. It appears from Fig. 3 that for a constant temperature difference and linear velocity, that the rate of heat transfer decreases linearly with increase of per cent solids in the thick liquor.

There is some indication, from data not presented in this paper, that the rate of heat transfer varies with temperature driving force. These data were incidental, however, and are not sufficiently complete to warrant any conclusions. There is little agreement on the effect of this variable on heat transfer coefficients

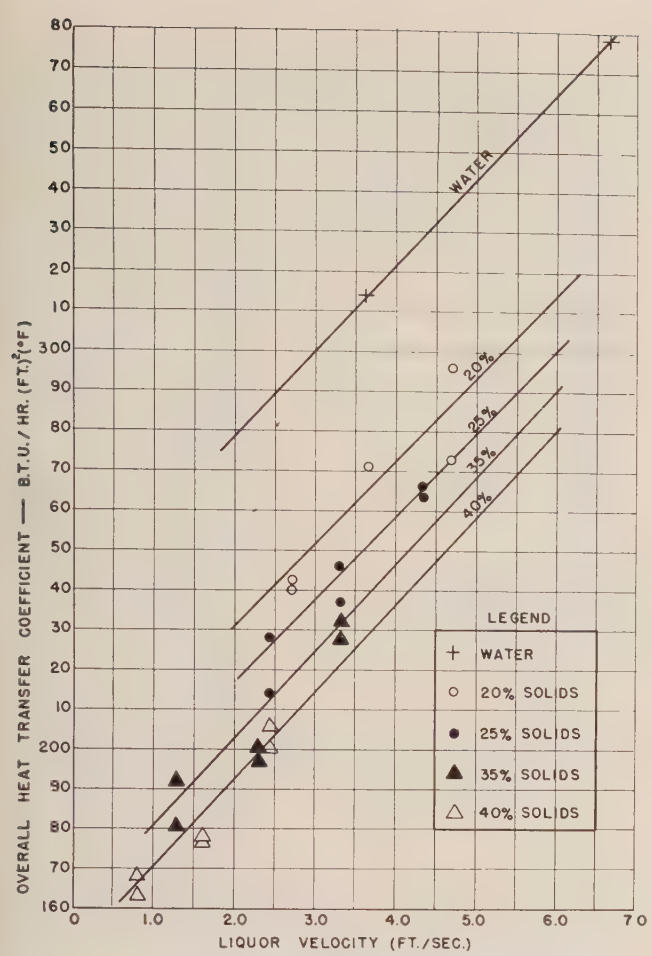


Fig. 2. The effect of liquor velocity on over-all heat transfer coefficient at constant temperature difference

as reported by previous investigators. Moore (*5*) has published results on the evaporation of calcium-base sulphite waste liquor which indicate that the coefficient increases with increase of temperature difference. Fragen and Badger (*6*), on the other hand, conclude that it varies inversely with temperature difference. It is the intention of the authors, now that the effects of liquor velocity and concentration are established, to investigate the effect of temperature difference.

Although some difficulty was experienced due to foaming in the vapor space the equipment produced no serious entrainment of vapor within the range of conditions it was operated. Neither was there any noticeable scale formation or fouling of the tubes throughout these experiments.

There was serious pit corrosion of the vapor space chamber which was not discovered until after these experiments were completed. With reference to Fig. 1 the head space was constructed of type 316 stainless steel sheet and attached to the tube sheet by means of a mild steel flange which was clad with type 316 stainless steel. This clad flange was corroded through to the mild steel in several places. The shell of the vapor space was also corroded through in several places, particularly at the level of liquor determined by the recycle line.

It is believed that corrosion in these places was aggravated by intermittent use of the equipment and by the fact that there was no provision for draining liquor from the bottom of the vapor space. The same type of corrosion was noted, however, although to a lesser degree, in both the top and bottom tube sheets. No scaling or corrosion of the tubes was observed. It did appear, however, that scale had been deposited wherever serious pit corrosion occurred in other parts of the equipment.

RECOVERY OF AMMONIA

Several attempts have been made to recover ammonia from waste liquor by pyrolysis or combustion of the concentrated liquor. Literature and data available to the authors indicate rather incomplete and sporadic results from these experiments. This situation may result from the difficulty in controlling a reducing atmosphere, in the case of complete combustion, and the fact that nitrogen passes so readily from one valence to another.

It has long been known that solutions of simple ammonium salts will liberate ammonia gas when they are heated if the solution is maintained sufficiently alkaline. Richter (*7*) has proposed that this principle be taken advantage of to recover ammonia during the evaporation of ammonia-base waste sulphite liquor. As far as known to the authors his proposal has never been reduced to practice.

It would generally be uneconomical to use commercial alkalies to produce the necessary alkalinity to effect this process. The purpose of this investigation was to evaluate the efficiency of industrial wastes, such as soda or kraft black liquors, as neutralizing agents prior to the evaporation of mixtures of these liquors with ammonia-base waste sulphite liquor.

Equipment

A preliminary investigation on a glassware scale of mixtures of kraft waste liquor and ammonia-base waste liquor had indicated the feasibility of the process. In order to increase the scale of operation, however, an indirectly heated, single tube evaporator was constructed and operated by Ayer and Stoddard (*8*).

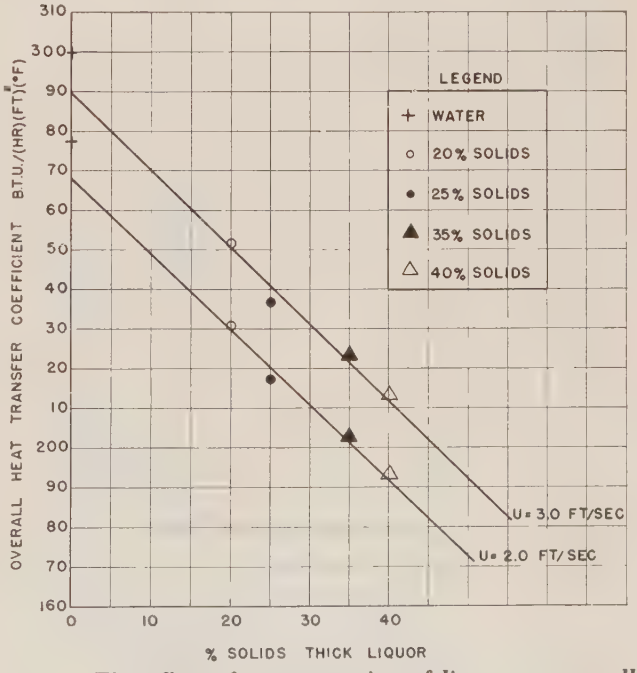


Fig. 3. The effect of concentration of liquor on over-all heat transfer coefficient at constant velocity of liquor and temperature difference

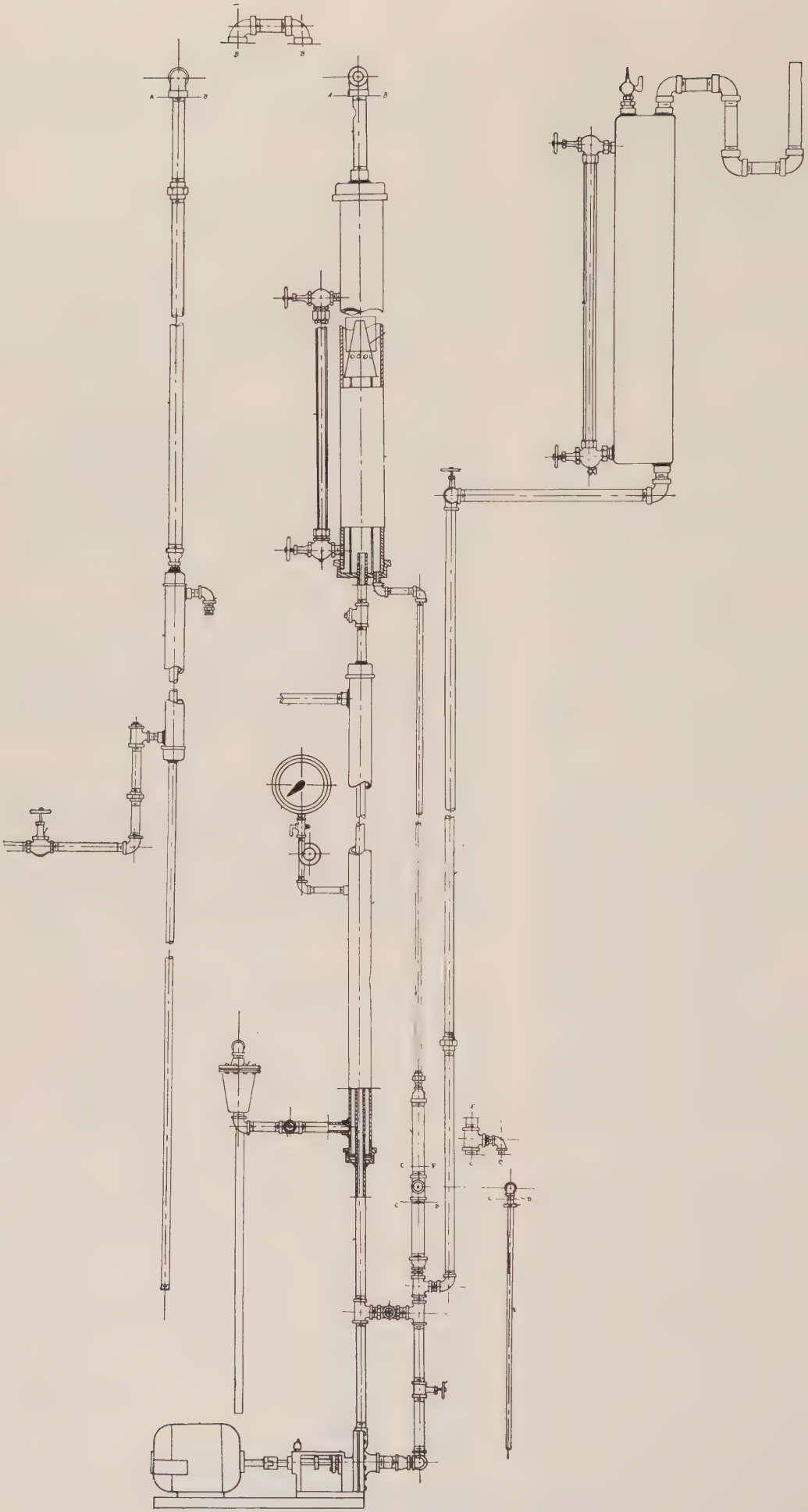


Fig. 4. Indirectly heated, single tube evaporator

This equipment, as shown in Fig. 4, consisted essentially of a feed tank, an evaporator body, a vapor space separator, and a water-cooled condenser with provision for recirculating liquor through the evaporator by means of a pump. The feed tank was constructed from standard 6-in. black iron pipe and was capable of being sealed. Heat was transferred through the wall of a standard $^1/_2$-in. black iron pipe, about 10 ft. of which was surrounded by a steam chest enclosed in standard 2-in. black iron pipe. The baffled vapor space was a 44-in. length of standard 4-in. pipe and the water-cooled, single-pass condenser was 43 in. long.

Procedure

Sulphite waste liquor was mixed in the feed tank with kraft waste liquor in predetermined proportions and sufficient in amount to permit subsequent evaporation. The sulphite liquor contained about 11% solids and the kraft liquor about 16% solids. This mixture was then fed to the bottom of the evaporator tube.

The mixture was heated and partially evaporated by maintaining a steam pressure in the steam chest of about 10 p.s.i.g. Concentrated liquor was removed from the recirculation line prior to admixture of feed. Water vapor and ammonia flashed from the liquors were led to a condenser where total condensation was effected.

This condensate was then collected in a standard solution of hydrochloric acid, as a solution of ammonium chloride for purposes of analysis. The condensate could, of course, if adequately cooled, be utilized for the preparation of raw sulphite acid.

The equipment was first brought to conditions of steady state, and then data were collected under conditions of continuous operation. The data included the average rate of feed and removal of thick liquor, steam pressure, and samples from the feed, thick liquor, and condensate streams. All samples were analyzed for their ammonia content and the feed and thick liquor samples were analyzed for total solids. Ammonia determinations were made by a modified Kjeldahl method and solids content was measured by drying. Measurements of pH were also made on the feed liquor and thick liquor.

The following results were then calculated for the observed data: mass rate of the liquid streams, solids and water material balances, percentage recovery of ammonia as distillate, concentration of ammonia distillate, and the length of time of contact between the liquor and heat transfer area.

A series of experimental determinations was made for mixtures of kraft liquor and sulphite liquor in the ratios of 2:1, 3:1, and 4:1 respectively, by volume.

Results

Table II contains results calculated from these experimental data. Results are arranged in groups of constant liquor ratios. Within each group they appear in increasing order of the fraction of feed evaporated.

Table II. Recovery of Ammonia from Mixtures of Kraft and Sulphite Waste Liquors

Run No.	*Volume ratio, kraft–sulphite*	*pH of thick liquor*	*Contact time, min.*	*Fraction evaporated*	*Conc. NH_3 in condensate, %*	*Percentage available NH_3 recovered*
22	2:1	10.2	3.3	0.10	0.96	67.2
19	2:1	10.0	3.7	0.29	0.29	83.7
32	2:1	10.2	4.7	0.33	0.35	85.0
20	2:1	10.0	10.7	0.55	0.18	93.6
20	2:1	10.0	10.7	0.61	0.18	93.6
28	3:1	10.6	2.8	0.12	0.32	88.0
16	3:1	10.9	5.0	0.39	0.18	91.2
30	3:1	10.8	3.4	0.40	0.24	96.0
26	3:1	10.7	4.2	0.48	0.17	97.7
27	3:1	12.6	7.3	0.64	0.14	99.8
17	3:1	12.3	5.6	0.66	0.14	100.0
29	3:1	12.4	8.9	0.70	0.14	100.0
13	4:1	11.0	4.0	0.28	0.22	94.5
11	4:1	11.2	4.3	0.36	0.19	93.8
10	4:1	12.3	4.8	0.51	0.14	98.0
12	4:1	12.9	4.6	0.62	0.14	98.6

Run numbers are those reported by Ayer and Stoddard (*8*) who performed the experiments and recorded observed data.

Discussion of Results

The percentage of available ammonia that was recovered, and the per cent concentration of ammonia in the condensate, are plotted in Fig. 5 with respect to the fraction of feed evaporated. Although data are shown for each of three ratios of kraft to sulphite liquor only one curve could be drawn for the two higher ratios of 3:1 and 4:1.

It will be observed from Fig. 5 that for a given fraction of feed evaporated somewhat larger recovery of ammonia is possible from the higher ratios of kraft to sulphite liquor. The higher recovery is, however, accompanied by a lower concentration of ammonia in the condensate. The percentage recovery of ammonia

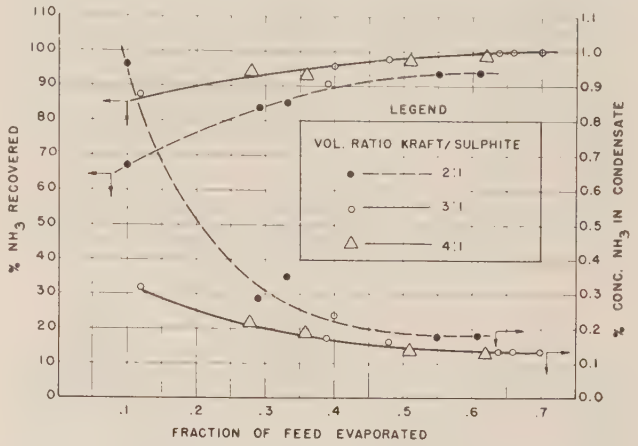


Fig. 5. Recovery of ammonia with respect to the fraction of feed evaporated

is large in all cases and should be attractive economically in those situations where sulphite waste liquor and an alkaline waste liquor are both available and the alkaline waste liquor is being evaporated and burned. The fuel value of solids in the sulphite waste liquor could then be utilized. The sulphur content of the sulphite waste liquor might also serve as make-up sulphur in the kraft process.

If such a recovery process is to be used the condensate from steam traps of the evaporator chests, after adequate cooling, could be utilized for the regeneration of raw sulphite acid. Assuming that such acid-making towers were to yield an acid containing 1% mill combined sulphur dioxide, the ammonia solution going to those towers should contain 0.5% ammonia. It will now be observed from Fig. 5 that this concentration of ammonia is not attainable from mixtures of kraft and sulphite liquors fed in ratios of 3:1 or 4:1. It is attainable, however, from a liquor ratio of 2:1 provided that the ammonia recovered is contained in condensate from not more than one fifth of the feed. This range of operation would allow the recovery of at least 75% of available ammonia. Obviously, if make-up ammonia is added as a strong solution, or andydrous ammonia, a larger fraction of evaporated feed could be utilized and more than 75% of available ammonia could be recovered.

It might also be economical to attain practically complete recovery of ammonia by stripping it from the condensates of later effects of a multiple effect evaporator. Such stripping could be accomplished by fractional distillation and an economic balance would show whether or not it is desirable.

Table II also contains the recorded pH of thick liquor from the evaporator and time of contact of liquor with heat transfer area. The latter is computed on a superficial volumetric basis.

As would be expected, higher values of pH result from the larger ratios of kraft liquor to sulphite liquor. Also

that except for the ratio of 2:1 the pH increases with the larger fractions of feed evaporated.

The time of contact was fixed, for a given heat transfer area and steam pressure, by the rate at which the feed could be supplied and allow the desired fraction to be evaporated. In all cases the time of contact was rather long. It was difficult to reduce the time of contact due to the marked tendency of mixed feed to foam. The tendency to foam was greater for the higher ratios of kraft liquor, possibly due to more rapid evolution of ammonia. There is a general direct relationship between the time of contact and fraction of feed evaporated, since the steam pressure was substantially constant.

Although operating difficulties were experienced as a result of the tendency to foam, no precipitate or sludge was observed during any of the tests.

CONCLUSIONS

1. The over-all heat transfer coefficients during evaporation of ammonia-base waste sulphite liquor in a long tube, vertical, forced circulation evaporator varied directly with the velocity of liquor entering the tubes and inversely with the concentration of solids in the thick liquor, when an approximately constant temperature driving force was employed.

2. Although no serious difficulty was experienced from foaming there were parts of the long tube evaporator consisting of type 316 stainless steel that were badly corroded.

3. From 67 to 100% of ammonia available in ammonia-base waste sulphite liquor can be recovered by mixing it with kraft waste liquor prior to evaporation of the mixed liquors.

4. The percentage of ammonia recoverable increases with the fraction of feed evaporated but the concentration of ammonia in the condensed vapors decreases faster than the former increases.

5. At least 75% of the available ammonia can be recovered by evaporation of 2 parts of kraft liquor and 1 part of sulphite liquor as a condensate that should be amenable to regeneration of raw sulphite acid.

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Concerning the Russell Formula for Gymnosperm Lignin

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Black spruce periodate lignin has been reacted with (1) hydroxylamine and (2) *p*-chlorobenzaldehyde. The oxime and benzylidene condensation products obtained contain less than 4.6% nitrogen and 5% chlorine, respectively. The Russell formula would call for products containing 7.3% nitrogen and 11.9% chlorine, respectively. This indicates that the Russell formula does not satisfactorily account for the properties of black spruce periodate lignin.

Several years ago, Alfred Russell (*1*) proposed that gymnosperm lignin was a polymerized form of 8-methoxydihydrobenzpyrone (I). His proposal has not been accepted by lignin chemists although their arguments for and against it have not appeared to date in the technical journals.

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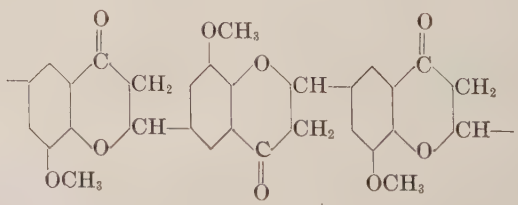
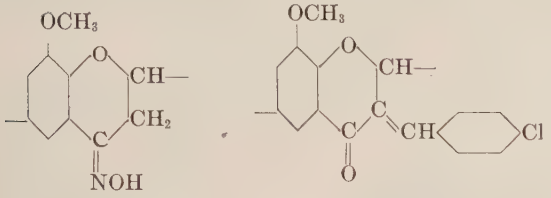
A series of experiments was initiated with the purpose of examining lignin in the light of this theory. Work has been completed on two aspects of this program. The lignin chosen for this work was the black spruce periodate lignin first described by Ritchie and Purves (*2*).



(I)

The evidence accumulated in these experiments indicates that Russell's formula does not account for the properties of the black spruce periodate lignin. The lignin was converted to an oxime containing only

4.5% nitrogen rather than the 7.3% nitrogen (II) which would be predicted on the basis of Russell's formula. The methylene group on carbon atom 3 ought to condense readily with *p*-chlorobenzaldehyde to produce a product containing 11.9% chlorine (III). Under conditions known to be effective with similar compounds (*3*), the periodate lignin produced a product containing less than 5% chlorine.



$C_{10}H_9O_3N$
% N = 7.3
(II)

$C_{17}H_{11}O_3Cl$
% Cl = 11.9
(III)

OXIMES AND OTHER CARBONYL DERIVATIVES OF LIGNIN

It is generally agreed that lignin contains a certain amount of carbonyl grouping in the molecule. However, the evidence available suggests that the amount of carbonyl present is considerably less than that called for by Russell's formula. While direct comparisons cannot be made, our results with hydroxylamine suggest that black spruce periodate lignin contains rather more carbonyl group than other isolated lignins, a result not too surprising since the relatively low per cent carbon in this form of lignin led Ritchie and Purves (*4*) to suggest that it was oxidized during the isolation.

Several investigators have reacted isolated lignins with hydroxylamine and have characterized the products as oximes. Klason (*5*) reacted a spruce lignin sulphonic acid with hydroxylamine in the presence of 2-naphthylamine hydrochloride. The resulting product contained 3.15% nitrogen. It is not certain that this product is an oxime since 2-naphthylamine alone gives a nitrogen containing product. A similar reaction with semicarbazide in the place of hydroxylamine produced another product but no nitrogen analyses were reported. Doree and Barton-Wright (*6*) converted an alkali lignin from spruce into an oxime containing 6.8% nitrogen. Freudenberg and Plankenhorn (*7*) reported the preparation of an oxime from the acetic acid lignin of spruce. The method of preparation was not given but presumably it involved hydroxylamine. The product was found to contain between 1 and 2% nitrogen.

Other carbonyl derivatives have been reported for lignin. Doree and Hall (*8*) reported the preparation of a hydrazone from a spruce lignin sulphonic acid. This may have been a hydrazide. In any case, the product contained 4.3% nitrogen and the copper number closely correlated with this value, suggesting that the carbonyl group was an aldehyde. This corresponded to 1 carbonyl group for every 26 carbon atoms.

Powell and Whittaker (*9*) reported that the alkali lignin from flax shives reacted with phenylhydrazine to form a phenylhydrazone but they did not report the per cent nitrogen in the product. Instead they used an excess of phenylhydrazine and determined the extent of reaction by the decrease in phenylhydrazine in their reacting solution as well as the weight of precipitate obtained. The amount of carbonyl so indicated (2.5 to 2.7%) was a trifle lower than the amount of aldehyde (3.1%) suggested from a copper number determination. A few years later, Friedrich and Diwald (*10*) prepared a phenylhydrazone from spruce lignin isolated by alcoholysis. They carried out the reaction in alcohol using phenylhydrazine hydrochloride in the presence of sodium acetate. This product contained 2.3% nitrogen. A similar procedure with semicarbazide hydrochloride produced a product containing 3.04% nitrogen.

The phenylhydrazones of a variety of "native lignins" have been prepared by Brauns (*11*) and Nord (*12*) by the reaction of phenylhydrazine with dioxane solutions of the lignins at 80°C. Generally the extent of reaction was calculated from the decrease in methoxyl content. In the case of the native lignin of aspen (*11b*), Brauns reported a product containing 1.4% nitrogen, and this checked well with the change of methoxyl content. In this case, the data suggested about 1 carbonyl group for every 10 phenyl propane units. Lignins other than aspen, where per cent nitrogen was not reported, generally showed more carbonyl than this. In the case of black spruce native lignin (*11a*), Brauns' data suggest 1 carbonyl group for every 4 to 5 phenyl propane units.

Recently Merewether (*13*) has reported the preparation of carbonyl derivatives of a variety of lignins from *Eucalyptus regnans*. He has studied both alkali and thiolignins, preparing osazones and *p*-nitrophenylhydrazones. Merewether believes that the formation of osazones indicates the presence of the —CHOH—CO— group in his lignin. The nitrogen contents of these products varied from 3 to 5% nitrogen. These results were interpreted as suggesting 1 carbonyl group for every 4 to 6 phenyl propane building units, depending on the kind of lignin used.

Hess and Hermann (*14*) used hydrazine to form a derivative of lignin. Reasoning that most methods of isolation of lignin produced a polymeric material due to the reactive carbonyl groups present, they ground up rye straw in the presence of hydrazine hydrate. Extraction of the residual wood with 80% alcohol removed practically all of the lignin as a hydrazone or azine containing 6.1% nitrogen. The method was less successful when applied to spruce and beech and the analyses of the extractable portions were not given (*15*). Earlier, Freudenberg (*16*) had heated cuproxam lignin from spruce with anhydrous hydrazine at 140° but he did not analyze the product.

OXIMES OF BLACK SPRUCE PERIODATE LIGNIN

With the exception of the oxime (*6*) and phenylhydrazone (*8*) prepared by Doree these results indicate that there is at best a single carbonyl group for every 4 to 7 phenyl propane building stones. In the case of our black spruce periodate lignins, the nitrogen content of the oxime suggests somewhat more than 1 carbonyl group for every 2 phenyl propane units.

To make these oximes a solution of hydroxylamine hydrochloride was prepared. To liberate the free hydroxylamine, a weak base such as sodium bicarbonate or sodium acetate was added. The lignin was suspended in this solution and refluxed for several hours. The product was recovered by filtration and analyzed for nitrogen by the Kjeldahl method (*17*). The results of some of these experiments are summa-

rized in Table I. Repetition of the experiments with fresh solution acting on the oxime failed to increase its nitrogen content significantly.

Table I. Preparation of Lignin Oximes from Black Spruce Periodate Lignin

Method A	*Reflux 24 hr.*	*Reflux 48 hr.*	*Reflux 53 hr.*	*Reflux 42 hr.*
Weight lignin, g.[a]	0.260	0.250	3.50	1.15
Weight $NH_2OH \cdot HCl$, g.	1.106	1.083	3.50	1.17
Weight $NaHCO_3$, g.	1.010	1.005	3.50	1.16
Volume H_2O, ml.	30	30	30	30
Recovery, weight %	78	73	74	...
N in product, %	3.51	4.39	3.41	3.8

Method B	*Reflux 24 hr.*	*Reflux 96 hr.*	*Reflux 96 hr.*
Weight lignin, g.[a]	0.273	0.247	1.004
Weight $NH_2OH \cdot HCl$, g.	3.027	3.063	10.04
Weight $NaC_2H_3O_2 \cdot 3H_2O$, g.	3.022	3.027	10.65
Volume H_2O	30	30	100
Recovery, weight %	81	77	...
N in product, %	4.18	4.54	4.57

[a] Air dried.

An oxime was prepared and analyzed for carbon, hydrogen, methoxyl, and nitrogen. These analyses, together with the analyses on the original lignin, are presented in Table II. The reaction between hydroxylamine and a ketone is as follows:

$$R_2C = O + NH_2OH \rightarrow R_2C = N—OH + H_2O$$

It is clear that the net effect of this reaction should be to add 1 nitrogen atom and 1 hydrogen atom to the molecule every time a carbonyl group reacts. The number of carbons, oxygens, and methoxyls should remain unchanged. The per cent carbon, oxygen, and methoxyl should, of course, fall due to the added weight of the nitrogen and hydrogen.

Table II. Analyses of Black Spruce Periodate Lignin and Its Oxime

	Lignin	*Av.*	*Lignin oxime*	*Av.*
C, %	60.04		60.30	
	60.02	60.03	60.42	60.36
H, %	5.03		5.17	
	5.12	5.07	5.11	5.15
OCH_3, %	11.22		12.13	
	11.00	11.11	11.98	12.05
N, %	0.12		3.70	
	0.11	0.12	3.66	3.68

Note: All values on a dry, ash-free basis. Samples dried at 45°C. *in vacuo*. Ash calculated on residue from carbon-hydrogen determinations (0.60 ± 0.05% for the lignin, 0.74 ± 0.01% for the oxime).

An examination of the data in Table II shows that this is not realized. Instead, the per cent carbon and methoxyl rises slightly. Generally the yield of oxime is from 70 to 80% of the weight of the original lignin. We interpret these high values for per cent carbon and methoxyl as indicating that, in the process of oxime formation, the more highly oxidized portions of periodate lignin are solubilized. Speculating still further, we have calculated the composition of the lignin which would give rise to an oxime of the composition shown in Table II had the reaction proceeded according to the simple equation written above. Such a lignin would contain 62.8% carbon, 5.1% hydrogen, and 12.6% methoxyl.

This suggests that black spruce periodate lignin may contain a fraction rather closely resembling the native lignin from spruce, isolated by Brauns (*18*). His product contained 63.8% carbon, 6.19% hydrogen, and 14.7% methoxyl.

One procedure was developed for making an oxime containing about 8% nitrogen. However, as the yield under these conditions was only 15%, it was felt that this was not a very significant finding. The conditions are indicated in Table III. The loss of material occurred in the first step where acetic acid was used as a solvent for the hydroxylamine. Attempts to recover the products from the acetic acid filtrates were not successful.

Table III. Lignin Oximes of High Nitrogen Content

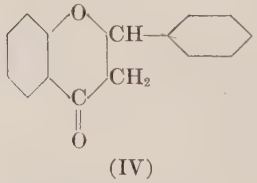
	First reflux	*Second reflux*
Weight lignin, g.	2.01	0.35
Weight $NH_2OH \cdot HCl$, g.	4.40	2.50
Weight $NaC_2H_3O_2 \cdot 3H_2O$	...	3.13
Volume of acetic acid, ml.	50	...
Volume of water, ml.	...	30
Reflux time, hr.	96	24
Recovery, weight %	17	95
N in product, %[a]	5.10	8.21
C, %[a]	...	59.6
H, %[a]	...	4.38
OCH_3, %[a]	...	7.59

[a] Oven-dry basis. The periodate lignin used for the preparation analyzed 59.6% C, 5.32% H, 11.38% OCH_3.

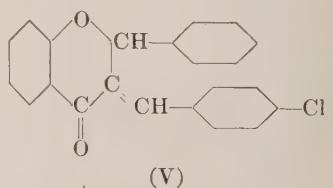
BENZYLIDENE DERIVATIVES OF LIGNIN

The reaction of an aldehyde with the active methylene groups in lignin has recently been investigated by Merewether (*19*). He used a thiolignin and an alkali lignin from *Eucalyptus regnans*. Under warm alkaline conditions, he condensed these lignins with both benzaldehyde and *p*-nitrobenzaldehyde. His analyses indicate a reaction to the extent of about one mole of aldehyde to every 59 nonmethoxyl carbon atoms (or every 5 to 6 phenylpropane units). Pfeiffer (*20*) condensed chromanones with aromatic aldehydes, but when we applied these conditions to flavanone, a model for Russell's formula, identifiable products were not obtained (*21*).

Methylene groups of the dihydrobenzpyrone type postulated by Russell are present in the flavanones. These compounds condense readily with aromatic aldehydes in the presence of refluxing alcoholic hydrogen chloride (*3*). We applied these conditions to the reaction between flavanone (IV) and *p*-chlorobenzaldehyde producing 3-(*p*-chlorobenzylidene)-flavanone (V), m. p. 136°. Calculated for $C_{22}H_{15}O_2Cl$: Cl, 10.2%. Found: Cl, 10.1%.



(IV)



(V)

For these reasons acid rather than alkaline conditions were used in our condensations with periodate lignins. The *p*-chlorobenzaldehyde was dissolved in methanol and the lignin suspended in this solution. Dry hydrogen chloride was passed through the stirred solution

while it was being refluxed for several hours. The product was collected by filtration, washed with alcohol and ether, and finally extracted with ether in a Soxhlet extractor. The resulting product contained only 3.9% chlorine after one such condensation and subsequent condensations failed to change the chlorine content significantly. When the methanol was replaced with ethanol or dioxane, the maximum chlorine content obtained was 5.0% and 3.2%, respectively.

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Some Observations on the Causes and Prevention of Kraft Digester Corrosion

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Carbon steel kraft digesters generally gave good service life up to 1934–35. Since that time, undetermined changes have been made which cut the life to as little as 1 to 2 years. This shortened life may be due to one or more factors or changes in the digester proper or in the pulping operation. This paper has outlined variables in the steel, the liquor, and the circulation which may influence corrosive or erosive attack. Results of chemical, spectroscopic, and microscopic examination of digester steel samples are included. A method used in increasing the life of seriously thinned digesters is described. There apparently is no clean-cut cure-all for the excessive corrosive attack. There are probably other contributing factors and better methods for controlling attack. It is hoped that this paper may tend to emphasize the scope and ramifications of this expensive problem and stimulate thought along all lines that may contribute to decreasing the rate of corrosive and erosive attack.

What has happened to carbon steel kraft digesters since 1935–36 to cause the greatly increased rate of attack? Has the thinning been due to changes in the chemistry or method of manufacture of the steel, the process of fabrication of the vessels, differences in the composition of the cooking liquor, pulp, or to faster cooking, circulation, etc.? The evidence so far seems to indicate that the failures which have and are occurring do not fall into a general pattern. It is probable, therefore, that many factors are responsible for this accelerated attack which has developed in the past 16 to 17 years.

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In 1948, the author was asked to consider the problem as to why the present-day carbon steel digesters were failing so rapidly. He had already realized that the problem existed while examining stainless steel fittings and linings which were causing trouble. During the session which drew him into the project actively, the general background of the subject was explained. The feelings expressed were that failure was due to a difference in the chemistry and method of steel manufacture. Since then the author has discussed the problem and examined digesters over much of the country. As you know, the blame is still placed on the steel.

STUDY OF STEELS USED

In order to check on the steel changes, it was suggested that samples be taken from digesters which had given good and poor service life. These samples would then be checked for chemical composition both by wet analysis and spectroscopic means. It was felt that if enough information on composition versus life could be established, then definite trends could be developed which might point out undesirable characteristics in the steel which should be avoided. The spectroscopic analysis would determine whether some of the so-called tramp elements were contributing to the increased corrosion rates.

In addition to the chemical analysis, it was decided to study the structure of the steels microscopically in order to determine the type of steel, any unusual structures, and especially the type of inclusions present.

A number of these steel samples were secured and the results obtained are given in Table I.

It is difficult from the figures outlined in Table I to determine what characteristics in steel chemistry are required for good service life. Samples E-1 to 4, and M-1 and 2 are from different mills. The chemistry of the steel is very similar and could easily have come from the same heat. However, one digester gave 2 years of service life while the other gave 10 years.

Samples 1 and 5 are higher in manganese while lower in sulphur, copper, aluminum, and tin, than samples E and M. The service life was 13 and 14 years.

Samples A and B are lower in carbon, sulphur, copper, chromium, and tin and higher in silicon and phosphorus. The service life is 18 and 27 years.

Sample 6 could be from the same heat as sample A as far as chemistry is concerned. In this case the life was 19 years.

Samples 4-E and W and 5-E and W are different in chemistry and service. These are rimmed heats with about $^3/_{16}$-in. rim on each side. They have been in soda service for about 27 years. Recently, however, the service was changed to kraft and the rate of attack has increased very noticeably.

INSPECTION OF DIGESTERS

In examining digesters, there was the fact that corrosion was not uniform in nature and actually nonexistent in some mills. In some cases it occurred in the dome, in others on the side walls or cone. In many cases the attack was in the form of pits or grooves, in others, large areas were thinned down without sharp outline.

Case 1

Inspection of digesters in one mill showed several interesting phenomena. The digesters had been in service for 24 months. They were constructed of A-212 steel, fusion welded and stress relieved at 1100 to 1200°F. Attack had developed to a depth of $^3/_{16}$ to $^7/_{16}$ in.

This attack was largely confined to the side walls in the form of deep pits and grooves. Many of the grooves were as much as 2 in. wide with pits ranging up to the same diameter. There was a marked directional pattern to the attack with the pits and grooves following a well-defined vertical pattern. While some thinning had occurred in the lower portion of the first digester examined, the most serious effects were in the upper portion of the side walls. This appeared also to form a pattern which angled down from a high point on the west side of the digester to a low point on the opposite wall. Below that line, there was random thinning; above, attack appeared as vertical streaks. In order to check the pattern, the digester was partially filled with chips. The angle of the dividing line of random versus the patterned attack coincided with this angle of repose of the chips. More chips were added and the same condition continued.

Below the angle dividing line, a thermometer well, also on the west wall, extended into the vessel. Underneath the thermometer well, there was a bayonet-shaped groove about 30 in. long extending in a downward direction.

Why had serious pitting developed in such a pronounced pattern above the line corresponding to the angle of chip repose? Also, why had the groove formed in such a marked pattern under the thermometer well while there was very little sign of attack in the adjacent areas? The difference in chip packing seemed to provide the only answer. Above the line which extended to within several feet of the knuckle radius on the west side, the chips probably were loosely packed in a random manner. Under the line, the direct fall had tended to pack the chips together. The same loose packing

Table I. Data on Digester Steels Tested

	E-1	*E-2*	*E-3*	*E-4*	*M1*	*M2*	*A*	*B*	*1*	*5*	*4E*	*4W*	*5E*	*5W*	*6*
Chemical and Spectroscopic Analysis															
C	0.21	0.23	0.24	0.24	0.24	0.24	0.16	0.135	0.25	0.25	0.06	0.07	0.85	0.095	0.16
Mn	0.44	0.45	0.43	0.42	0.44	0.42	0.47	0.44	0.52	0.50	0.38	0.36	0.40	0.40	0.47
P	0.012	0.012	0.011	0.012	0.012	0.011	0.015	0.013	0.012	0.010	0.018	0.018	0.015	0.015	0.015
S	0.038	0.038	0.037	0.037	0.037	0.038	0.027	0.027	0.030	0.028	0.043	0.040	0.033	0.035	0.027
Si	0.07	0.08	0.08	0.08	0.08	0.08	0.11	0.11	0.07	0.09	0.01	0.01	0.02	0.02	0.10
Ni	0.05	0.04	0.05	0.05	0.04	0.05	0.03	0.06	0.06	0.08	0.04	0.04	0.03	0.04	0.02
Cu	0.18	0.18	0.17	0.16	0.16	0.16	0.03	0.05	0.03	0.03	0.16	0.15	0.14	0.15	0.03
Cr	0.04	0.04	0.04	0.04	0.04	0.05	0.01	0.02	0.04	0.04	0.04	0.04	0.04	0.04	0.01
Mo	0.02	0.02	0.02	0.02	0.02	0.02	0.02	Nil	0.03	0.03	0.02	0.02	0.02	0.02	0.02
Al	0.005	0.004	0.005	0.006	0.004	0.003	0.005	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.0045
Sn	0.04	0.05	0.03	0.05	0.05	0.04	0.008	0.014	0.015	0.010	0.015	0.015	0.010	0.010	0.008
Brinell Hardness															
					...	...	...	...	127	127	...	99	...	89	107
Quality—Chevy Nonmetallic Inclusion Chart															
Oxides					...	...	...	...	4	4	3	3	3	3	5
Sulphides					...	...	...	...	4	4	4	5	5	5	5
Silicates					...	...	...	...	2	2	6 (1)	8 (2)	9 (3)	8 (3)	3
Type Steel															
					...	...	...	...	Killed	Killed	Rimmed	Rimmed	Rimmed	Rimmed	Killed
Type Welding															
	Fusion				Fusion			Hammer		?		Hammer		Hammer	Hammer
Service Life															
	2 years				10 years		18	27	14	13	28[a]		28[a]		19
Spectroscopic tests for Pb, B, W, Ti, Cb, Zr, Sb, As, Co, Ta, Zn, Bi—nil.															

[a] Soda until recently.

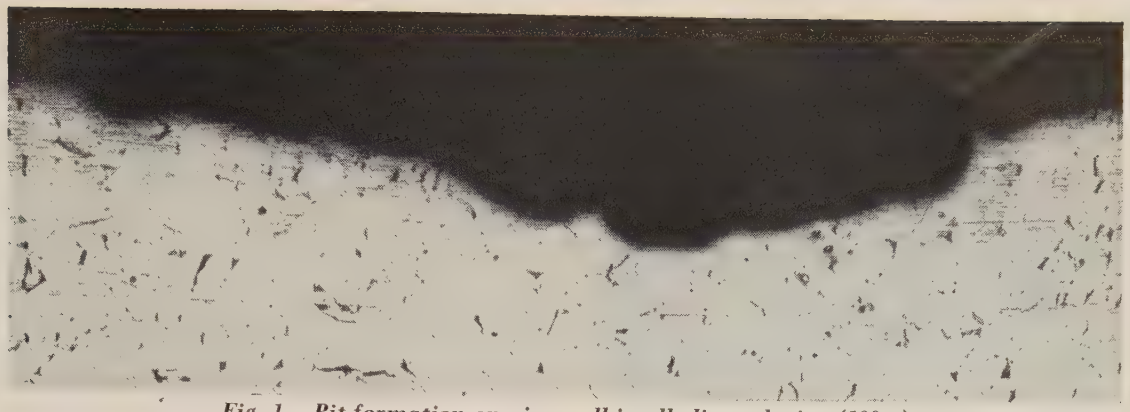

Fig. 1. Pit formation on pipe wall in alkaline solution (100×)

undoubtedly took place under the thermometer well. In the areas of loose packing there may have been more continuous voids along the side wall permitting rapid fluid and gas flow to take place along a more or less continuous vertical path.

Wax casts were made of the depressions and from these, plaster casts were developed. It was hoped that the shape of these casts could be studied and the direction of the gas or fluid flow along the wall determined. We could not be sure from the patterns secured but feel that further carefully selected grooves might show whether the path of the fluid flow was up or down.

The complete examination showed some areas where attack had developed along both vertical and girth welds. This was of minor character as compared with other areas.

The digesters do not set directly under the chip bins and the loading and packing are all against the west wall. In all digesters in this plant, the west wall shows the least attack.

Case 2

We recently had an opportunity to inspect a hammer-welded digester installed in 1929. A circulation pipe installed in the head directed liquor against the knuckle radius and dome. In this area, serious thinning developed in a short period of operation and the circulation through the spray pipe was dicontinued. The digester has been in service since that time with very little further thinning. However, another area in the dome has been attacked through the impingement of liquor during the last year.

It is interesting to note that from 1929 until this date, little or no attack developed in the area damaged earlier. Again, in 1951–52, attack took place which can be traced to the impingement of liquor on the dome. The thinning in both cases can be attributed to the washing effect of the spray on the steel.

Case 3

A digester installed in 1950 was inspected after about 18 months of operation. A heavy scale had built up over most of the side walls and in the cone. In the dome and irregularly around the upper side walls, scale had not built up. These areas were being attacked irregularly.

Areas covered with the original mill scale were still present in the dome. The pattern of scale removal could be read from the contour of the steel surface. Areas, where the scale had broken off first, showed the deepest pits. Around these were series of steps where scale had subsequently been removed at later dates. Those areas with the mill scale still attached were at the original surface elevation.

This type of attack coincided with previous work carried on in the examination of $1^1/_2$-in. standard welded, low-carbon steel pipe. The walls of this rimmed steel pipe had perforated in 2 to 3 months in a slightly alkaline solution. The potential difference between the mill scale and the pitted areas showed as much as 0.43 v. using a buffered potassium chloride solution (pH 7). The pitted areas were anodic.

The mill scale inside the pipe had been broken during welding operations and mechanical handling. It is felt that the very rapid perforation was due to the galvanic cell set up between the relatively large cathodic mill scale areas and the small areas where the mill scale was removed or broken. We believe that the large mill scale areas in the digesters are contributory to the increased attack on the mill scale free areas, the effect decreasing as the scaled areas diminished in size.

Figure 1, taken at 100×, shows a cross section through a pit formed on the inside wall of the pipe, subjected to caustic solution.

Case 4

The examination of 6 by 6-in. samples which were

Table II. Chemical Examination of Irregularly Attacked Steel from Tumbling Digester

Sample→	*C*	*Mn*	*P*	*S*	*Si*	*Ni*	*Cu*	*Cr*	*Mo*	*Sn*
T-1 (at A)	0.13	0.45/0.48	0.042	0.075	0.01	0.01	0.12[a]	0.02	0.01	0.03
T-1 (at A)	0.15	.....	0.048	0.054	...	...	...	...	...	...
T-1 (at A)	0.15	0.39	0.026	0.030	...	...	...	...	...	...
T-1 (at B)	0.11	0.41/0.42	0.028	0.035	0.01	0.01	0.12[a]	0.02	0.01	0.03
T-1 (at B)	0.15	0.39	0.029	0.032	...	...	...	...	...	...
T-2	0.20	0.36/0.40	0.010	0.029	0.01	0.01	0.04[a]	0.02	0.01	0.01

[a] Rechecked.
Tested for B, W, Pb, Ta, Co, As, Sb, Zn, Cb, Ti, Al—spectroscopically. Not detected.

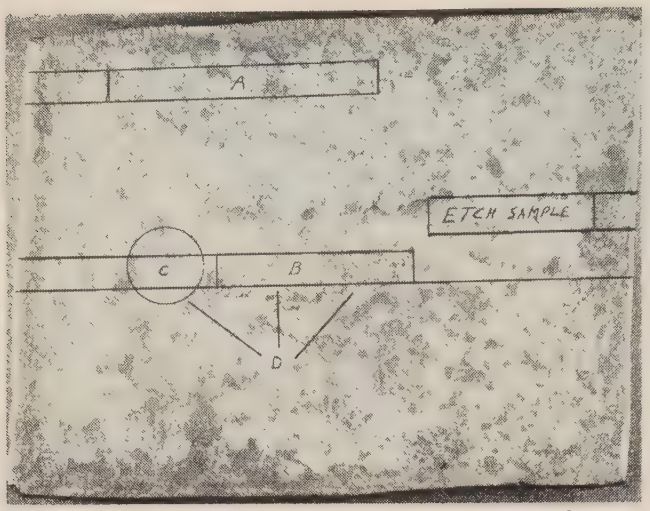

Fig. 2. Surface of sample T-1 showing location of specimens taken and threaded insert (1×)

taken from a rotary digester has just been completed. Sample T-1 ranged in thickness from 0.516 to 0.566 in. The inner surface showed the results of preferential attack in the center of the test plate. Sample T-2 did not show any marked difference in the rate of attack. The thickness on sample T-2 ranged from 0.596 to 0.609 in.

Pins were cut from the high and low areas of the sample T-1 and one pin from sample T-2. These pins were checked by spectroscopic methods for chemistry and trace elements. In the same respective areas, drillings were taken for wet chemical analysis. The results of the wet and spectroscopic analyses are shown in Table II.

The chemical analyses show marked differences in sulphur, phosphorus, and carbon contents of the samples taken from T-1. There are other factors besides chemistry of the steel which complicate this case. When samples were cut for spectroscopic analysis pins, cracks were noted in the thinned area. These cracks are shown in Fig. 3 at 1× after magnafluxing to better illustrate the badly cracked condition. Furthermore, the cut went directly through a threaded pin insert, which also appears in the plate cross section in Fig. 3. A sample, cut and etched, also showed cracking to a depth of approximately 50% of the thickness and originating from the inside surface.

From the appearance of the threaded pin after etching it was determined to be of a free machining type carbon steel. The metal sample was insufficient for a complete chemical and spectroscopic analysis. It was run for carbon, phosphorus, and sulphur. The results are as follows: C = 0.05%, P = 0.200%, and S = 0.052 (checked). These figures indicate a Bessemer-free machining-type carbon steel.

Figure 2 at 1×, shows the appearance of the inner surface of the T-1 digester plate. It is marked to denote certain locations. A shows the location of the "edge" pin taken for chemical and spectroscopic examination. B shows the location of the "center" pin. C indicates where the threaded pin insert was located. DD is the cross section shown in Fig. 3. Etch sample denotes the point at which it was taken.

We do not know when the pin was inserted or for what purpose. It was indistinguishable from the surrounding steel and would not have been noticed if the cut had been located elsewhere. There was no difference in the attack on this pin from the steel directly adjacent.

Here, there is a very good indication of the relative effects of chemistry and structure of the steel on the rate of attack. There is a wide variation in the steel sample analyses from the same plate. We hope to check this sample more completely in order to account for the differences. Inserted in the plate, is a steel of entirely different chemistry and type of manufacture which would certainly not be recommended for firebox, flange, or digester quality steel. This pin has not suffered by thinning in comparison with the adjacent steel.

It is not known whether the threaded pin was inserted in the steel before or after the cracks in the plate developed. The etched sample through the pin showed cracks in the plate. The steel did not appear to be unusually dirty, however.

The chemistry of sample T-2 is somewhat different from that of T-1. Carbon is higher, phosphorus, copper, and tin lower. No cracks were found in this sample.

From the evidence obtained, it does not seem as though the chemistry of the steel itself was responsible for the thinning down of sample T-1 in the center, as compared with the edge. It is probable that other factors, such as the cracks and possible stressed condition of the steel, did have a direct bearing on the preferential attack.

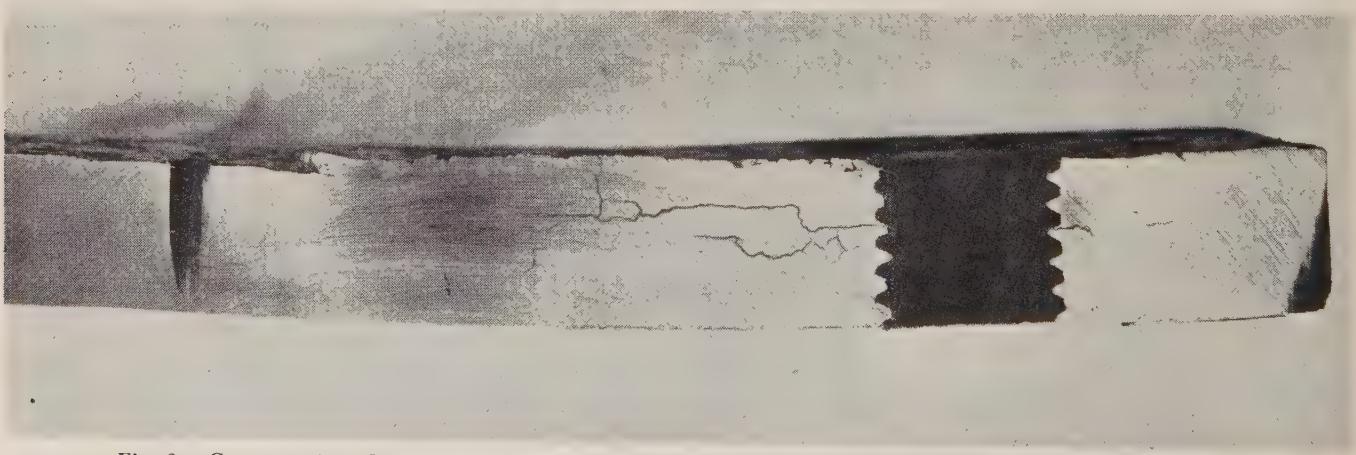

Fig. 3. Cross section through preferentially attacked plate showing cracks and threaded insert (1×)

LIQUOR CHEMISTRY AND ITS POSSIBLE EFFECT ON CORROSION

Much of the attention has been focused on differences in steel type and manufacture in order to account for digester failure. Little consideration has been paid to the possible effect of differences in cooking liquor chemistry.

There is one angle which has been given little or no thought. About 1934–35, the rotary furnace for black liquor burning started to be replaced by the waste-heat recovery-type furnaces. This time element coincides closely with the date at which increased corrosion rates started to become noticeable. It has been reported that sulphate to sulphide reduction in the rotary furnaces ran about 70 to 75%. In the most efficient modern spray-waste heat recovery furnace, the author is told that the sulphate to sulphide reduction may run from 90 to 97%.

In the "Corrosion Handbook" (*1*), attention is called to the inhibiting effect of sodium sulphate in an alkaline solution. The temperature at which the tests were run, 590°F., was much higher than that employed in the kraft digester and therefore the effect on the carbon steel is more severe. Attention is called to the fact that NaOH corrodes iron with the evolution of hydrogen. An increase in the concentration of NaOH caused a greater corrosion rate. The addition of sodium sulphate reduced the attack. The addition of sodium chloride reduced the protective effect of the sodium sulphate.

The article shows curves illustrating the effect on the corrosion rate of various concentrations of caustic soda and additions of various other chemicals.

If the Na_2SO_4 does have the inhibiting effect noted, then the increase in corrosion rate by the cooking liquor may have been caused or at least aggravated by the lower concentration of Na_2SO_4 present resulting from the much greater reduction of Na_2SO_4 to Na_2S. If this is true, the additions of Na_2SO_4 to the cooking liquor might be beneficial.

The reduction of Na_2SO_4 concentration may also have a marked effect on the quantity of scale and the type formed. This could depend also on the difference in clarification and calcium content of the white liquor. The combination of the sulphate and calcium radicals to give a calcium sulphate scale would be effected by the content of both in the liquor.

The addition of sodium chloride might also have a deleterious effect and aggravate the corrosiveness of the cooking liquor on the carbon steel. The presence of NaCl in cooking liquor should be checked.

There is also the possibility that complex sulphide compounds formed in making up the cooking liquor may have a definite inhibiting effect on the corrosiveness of the cooking liquor. The methods of making up the cooking liquor should be studied thoroughly in order to determine its effect on the rate of attack.

USE OF DEFLECTORS IN SCALE FORMATION

During the Audigage examination of a digester, an unusual pattern of scaled nonattacked area versus scale free attacked areas was noted. The attack was confined to the dome and extended irregularly down the side walls. An unused spray pipe installation apparently had some effect on the pattern of the scaled and unscaled areas. The most likely cause might be the change in circulation of liquor or gas caused by the baffling effect on circulation.

It was decided to check the effect of circulation, feeling that, if scale could be built up, attack would stop. A strip of light gage stainless steel was spot welded around a portion of the digester wall so that it extended about $1^1/_2$ in. from the wall. It was in an area free from scale and showing active attack. The strip was fastened to the side wall with a downward angle of about 45° to the digester wall. In such a position, the so-called deflector would interfere with the upward flow of liquor or gas passing along the side wall, causing stagnant liquor areas to form along the walls. This could cause scale to deposit above the dam for some distance. The pattern, however, indicated that the angle of the deflector should be changed to upward as the direction of flow along the wall was vertical down. Therefore, the deflector angle was changed to upward. In a month of operation a definite deposit of scale built up below the deflector. There is a pattern in the scale which shows the deflector is leaking where not in tight contact with the wall. Below these points of leakage, the scale did not deposit and the surface is streaked. Further tests should be run to prove or disprove the beneficial effect of such deflectors.

STAINLESS STEEL WELD METAL OVERLAY FOR REPAIR

During 1950, we were asked to suggest means by which a number of attacked carbon steel digesters could be kept in service until replacements were secured. These were the digesters discussed in Case 1 under Inspection of Digesters.

The suggestion was made, by members of our staff, to overlay the severely thinned areas with stainless steel weld metal which would stop further removal of the metal. As these vessels must come under the ASME Boiler Code for Unfired Pressure Vessels, it was jointly decided that physical test data should be secured, and the results taken up with the Insurance Underwriters.

Plates of 1-in. thick A-212 steel were secured and grooves $^3/_{16}$ and $^7/_{16}$ in. deep by 2 in. wide machined into the surface. Stainless weld metal was laid into these grooves, one pass in the case of the $^3/_{16}$-in. and two passes in the $^7/_{16}$-in. deep grooves. Two types of stainless steel coated rod were used, namely, AISI types 308 and 310. Samples were prepared for tensile, yield, elongation, and bend tests. No attempt was made to smooth the surface of the weld metal by machining or grinding. The tests were run in the as-welded condition without stress relieving.

The results of the physical tests, together with photographs and photomicrographs of the test samples were included in the author's report entitled "Repair of A-212 Carbon Steel Kraft Digesters with Stainless Steel Weld Metal." The findings showed no tendency for separation of the weld metal from the base metal, either when pulled to destruction or bent 180° or to destruction. There was a marked difference in the results obtained with the type 310 versus the 308 weld metal. Tensile and yield strengths of the type 310 weld specimens were higher and met those called for in the ASTM "A-212 Grade "A" Specification for

Fig. 4. Type 310 stainless weld metal overlay about 3½ sq. ft. in area

Plate 1 in. and Under Fire Box Quality." Elongation on the type 310 specimens was well over the requirements while all type 308 samples gave results very much below those required. The bend tests also showed the type 310 to be superior—all bend tests with the stainless weld metal under tension as well as compression made the full 180° bend. The 308 bends with the stainless under compression made the 180° bend but with the weld under tension, the samples failed at from 10 to 30°. The microscopic examination showed that the failure in the 308 samples occurred at the stainless-carbon steel interface but in the stainless weld metal. The cracks were perpendicular to the direction of tension or bending and progressed in an outward direction through the stainless steel. There was very little penetration of cracks into the carbon steel. It was interesting to note that the cracks in the type 308 double weld bead samples stopped sharply at the interface between the first and second layers of weld bead. The failure of the type 308 overlay is undoubtedly due to dilution of the stainless steel with carbon steel during welding, and the resulting loss in ductility. In the case of the type 310, the higher alloy content permits dilution without lowering the alloy content to the point where ductility suffers.

On the basis of these test results and the report, certain of the Insurance Underwriters agreed to the limited application of stainless weld metal overlay using type 310 only.

Overlay No. 1

Some of the seriously thinned areas mentioned were welded over using type 310 stainless. Very small areas of carbon steel and stainless type 308 overlay were also applied. At the end of 6 months, the carbon steel deposits were badly attacked and cracked. The type 308 and type 310 weld metal was still in good condition. At the end of 18 months of service an attempt was made to cut the stainless weld metal away from the carbon steel. The bond was tight and no separation could be made. Metal chips were cut across the interface at the edge of one of these areas. The chips were small, curled up, and torn. A microscopic examination, Fig. 5 of the interface at 100×, shows a void which, if all is considered as attack, would amount to about 0.017 in. in 18 months on the carbon steel. Whether this is all due to corrosion is questionable. There may have been a fine void left at this point in the welding operation.

Large areas in the same plant have been overlayed. The original areas were examined after 22 months and there is little evidence of attack on the stainless and no accelerated attack on the carbon steel adjacent to the stainless. The larger overlays also are in excellent condition.

Overlay No. 2

Another mill inspection showed somewhat different attack to have taken place. In this case, hammer-welded digesters, dating back to 1924, were found by Audigage testing to have almost reached the limit of the corrosion allowance. The thinned areas were large, irregular in shape, and the metal removed without sharp steps or outlines. The location was on the side walls.

The problem was discussed in a meeting with the Underwriters' representative. It was agreed that type 310 stainless overlay welding should be applied to five digesters at the plant. The work would be carefully supervised. In the first digester, two areas were laid out, one about 3½ sq. ft. in area, shown in Fig. 4, the other about 33 sq. ft. The areas were outlined on the basis of the Audigage readings and rapid so-called perimeter beads laid in around the areas. Inside of this outline the fill-in beads were applied using a pass traveling slightly downward about 1½ to 2 in. to the foot. Each succeeding bead was laid on the shoulder of the preceding bead giving a shingling effect. In this way, the most diluted stainless area is covered completely by the succeeding bead. The shoulder of the lower holds the next molten bead in place.

It was thought that excessive temperatures in the carbon steel might develop and water was swabbed on periodically to cool the area down. However, the anticipated temperature rise did not take place and after a short time, water quenching was discontinued.

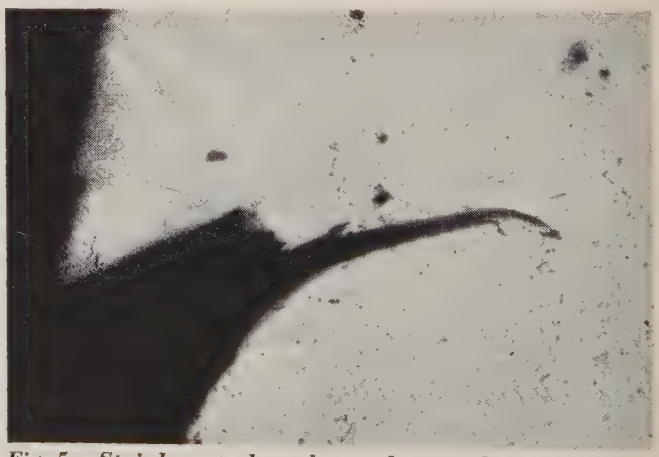

Fig. 5. Stainless steel overlay–carbon steel interface after 18 mo. service (100×)

The welding operations were carried on using $^1/_8$-in. lime-coated d.c. rod for the perimeter passes and $^5/_{32}$-in. lime-coated d.c. rod for the fill-in, all with reverse current. No preparation of the surface of the carbon steel was employed. The stainless steel weld metal was left in the as-welded condition.

The two areas have been examined after 6 months of operation. There is no sign of attack on the stainless steel overlay nor evidence of accelerated attack adjacent to the stainless steel on the carbon steel. However, the carbon steel did seem to be slightly attacked uniformly and possibly a shoulder is building up on the stainless steel. The areas will be carefully examined again in 6 months and if any attack develops adjacent to the stainless, one or more stainless beads will be laid around the perimeter extending the area outward.

Since the digester was completed and returned to service, four additional vessels have been given stainless steel overlay treatments ranging up to 57 sq. ft. in the largest single area.

This is simply a means for stopping corrosion and prolonging the life of the vessels. It is not proposed as a method for building up digesters which have been eroded to the point where pressures must be reduced in order to permit a return to original operating pressures.

ELECTRICAL POTENTIAL INVESTIGATION

If the mechanism causing accelerated corrosion can be determined, it is likely that remedies can be developed. We believe that we have one of the major causes under investigation in our corrosion laboratory. There may be other factors responsible for the failures, for instance those which do develop above the liquor line in the digester.

Attention has been called to the galvanic couple set up between the mill scale–scale free areas and the resulting attack on the digester. We have also noted the absence of anticipated galvanic attack on the carbon steel adjacent to the stainless steel weld metal overlay. Our laboratory has attempted to determine the reasons why the attack has not developed between the stainless-carbon steel couple and why it does occur in certain carbon steel to carbon steel areas.

Samples of stainless steel and A-212 carbon steel plate were cut, polished, cleaned, and lightly pickled. A piece of each was fitted into a fixture so that both could be lowered in a boiling bath at the same instant. They were connected by leads to a carefully balanced potentiometer so that the potential drop through the liquor could be measured. The initial voltage drop in boiling white and black liquor was 0.230 v. in each case. These values dropped rapidly so that, after 17 min. in white liquor, the voltage reading was 0.005. After 9 min. in black liquor, the reading was 0.000 v. and for a short period, there was a reversal in direction. In both cases, the stainless was cathodic and the carbon, anodic at the outset. Therefore, the carbon steel would be galvanically attacked rapidly the first few minutes. This attack would slow down as the potential difference dropped.

A very noticeable dark gray to black film built up on the carbon steel in the white liquor. The sample was well washed with water and then dipped in dilute hydrochloric acid. The film dissolved rapidly with the evolution of hydrogen sulphide. There was a very thin light-colored film on the carbon steel after immersion in the black liquor. The stainless steel surface appeared to be unaffected.

It was felt that the same galvanic effect might occur when a filmed piece of carbon steel was tested with a similar unfilmed piece. Therefore, the stainless steel was quickly removed at the end of the test period, a piece of polished and pickled carbon steel substituted, and the test rerun. Similar results were obtained with the filmed steel cathodic to the unfilmed. The initial voltage drop was 0.270 in the white liquor and 0.305 in the black liquor. The voltage readings decreased more rapidly in the black liquor than the white.

The film on the carbon steel retains its cathodic effect when dried and tested against a fresh, unfilmed carbon steel test piece.

Similar tests are now under way with additions of Na_2SO_4 to the baths. More will be run to determine the effect of NaCl and other chemical additions to the baths on potential drop and film effect. Another series will also be run using A-70 type steel in place of the A-212.

The films formed in the tests appear to be brittle and easily broken. This occurs during violent boiling of the baths and causes an increase in the voltage reading.

It is believed that these preliminary results indicate that the retention of a protective film over the entire digester wall is necessary in order to secure satisfactory corrosion resistance. Wherever the film, or in time scale is removed or broken, active corrosion takes place. Where the film forms, attack ceases and a heavy scale builds up which gives complete protection.

The protective scale may be removed by the washing effect of spray impingement or rapid circulation at the digester wall. Therefore, the first consideration should be directed to reducing the causes of erosion, the next, to developing stagnation of liquor or gas along the surfaces by the use of baffles, such as the deflectors discussed earlier.

The next phase to consider is the formation of more resistant films or scales. We hope to determine the effects of such chemicals as Na_2SO_4, NaCl, CaO, and others.

A third method for overcoming the local galvanic cell attack might be through cathodic protection of the liquor zone in the digester using superimposed current.

Such treatments may not aid in reducing the corrosion taking place in the dome above the liquor level. However, they could be considered as starting points.

SUMMARY

The chemistry of the steel does seem to have an effect on the life of digesters. The silicon-killed high tensile steels do appear to have a higher corrosion rate than the low silicon–low carbon, lower tensile strength types. However, this condition is modified by the other factors which should be classified as coming under the heading of operating problems.

The steel chemistry is important in securing sound steel which will be free from defects likely to introduce cracks in highly stressed or weak areas. A cracked condition such as that mentioned in Case 4, is an example of one which might be detected by supersonic testing.

Other conditions affecting life appear to be largely tied in with the factors causing erosion to develop. The erosion could result from liquor or gas flow or impingement on or along the cone, walls, or dome of the digester. We have seen digester attack caused by liquor impingement which lay dormant, after changes were made, for 25 years. The pattern of circulation of liquor is important and the direction of nozzles should be studied. It is possible that vertical convexity or concavity in the side walls may tend to affect fluid or gas flow along the walls and therefore have some effect on erosion and corrosion rate. For the same reason, any variation from the vertical in the side walls of the digester might affect the amount of flow along the wall and the rate of erosion. The direction of flow either up or down would have to be considered in this case.

Chip packing has been shown to have a marked effect on the rate and type of attack. Those areas where the packing has been loose, were seriously attacked whereas the tightly packed portions were subject to little or no attack. It has also been reported to the author, that one plant has noticed a distinct decrease in the corrosion rate on their kraft digesters resulting from greater chip density. This was accomplished by the introduction of chips and liquor at the same time. It also increased the chip charge and production.

Attention should be given to possible changes in cooking liquor which may have contributed to the increased rate of thinning. If the sulphate to sulphide ratio has had any effect, the direct introduction of Glauber's salt to the cooking liquor should be considered. It would not be lost as it would be converted to sulphide in the next reduction operation. The presence and effect of NaCl should also be checked.

The build-up of scale deposits on the surface of the digester appears to protect the steel surface underneath and these areas do not seem to be subject to corrosive attack. Any methods which will tend to cause scale to build up in corroding areas should be utilized to advantage. The installation of the deflector rings around the side walls has given an indication that retarding flow along the walls will cause scale to precipitate out on the surface. The proper location of such deflector rings on the side walls and possibly in the dome and at the knuckle radius may be an easy answer to reducing the rate of failure.

Use of the stainless steel weld metal overlay for the prevention of further attack on carbon steel digesters appears to offer promise. Several plants have used such overlays and results after 6 months to almost 2 years have been good. Little or no attack has developed on the stainless steel or on the carbon steel adjacent to the stainless. If attack adjacent to the stainless does occur, the area can be extended by the use of one or more additional weld beads around the entire area.

Test plates are being prepared for testing the application of the stainless overlay by automatic welding procedure. These will be physically tested to determine the effect of the welding operation on the steel plate. The results will offer information on the possible use of such a process for the lining of an entire digester.

Mill scale appears to offer excellent protection to the steel underneath. However, this seems to be a galvanic protection at the expense of the nonscale covered carbon steel which is attacked. In order to correct this condition so that the attack is uniform throughout and not concentrated at uncovered areas, the mill scale should be removed. This could be done by inhibited acid pickling which should give the ideal cleaned surface. Sandblasting offers a simpler method for scale removal. Galvanic cells resulting from filmed or scaled areas versus noncoated areas are believed to cause much of the damage.

Stray currents making certain areas anodic to other cathodic areas could also cause serious loss of metal. One ampere-year at 100% efficiency could remove approximately 20 lb. of iron. Any seriously thinned areas should be checked immediately to determine whether grounds exist which might be responsible for the metal loss.

CONCLUSIONS

The following conclusions are based on the results of our laboratory work, digester inspections, and plant installations where repair methods have been tried out:

1. Steel chemistry does not appear to be the major factor influencing service life.
2. Steel type, i.e., rimmed or killed does not seem to be the definite answer to long service life.
3. The high carbon-silicon killed steel does seem to have a greater tendency toward rapid attack.
4. The soundness of the steel may have a marked influence on the corrosion or erosion rate. This soundness may be affected by steel chemistry.
5. Circulation of gases and liquor impinging on or along the walls of the digester do affect the rate of attack.
6. Chip packing will affect the path of circulation and the attack.
7. All factors likely to affect circulation or impingement should be studied.
8. The effect of Na_2SO_4, NaCl, and other additions on the corrosion rate should be checked.
9. Stagnation of liquor along the walls will cause scale to build up. The possible use of deflector rings should be studied.
10. The proper stainless steel weld metal overlay can be utilized to extend digester life.
11. There is an initial potential difference between stainless steel and carbon steel which disappears with the formation of a protective film on the carbon steel.
12. There is a potential difference between a clean carbon steel surface and a filmed surface. This would explain the high rate of attack on the nonscaled areas which we believe are wiped by liquor flow or impingement.
13. Attacked areas should be examined for possible grounds.
14. The increasing rate of attack is due to a combination of causes.
15. Additional work and data are necessary to pin down the offending changes.

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Nitration as an Analytical Tool in the Study of Wood Pulps, IV

The Chemical Composition of Fiber Fractions from Nonbeaten and Beaten Fiber Materials

Ö. BRYDE, Ö. ELLEFSEN, and T. H. SMITH

The nitration procedure for studying wood pulp components has been carried out on various pulp fractions, classified according to the average fiber length. The apparent relationship between pulp properties, as for instance viscosity and fiber length, is discussed. The possibility that this relationship may be partly due to mixing of two components in different proportions is suggested. Similar investigations on beaten stock show that beating causes a transfer of high molecular to lower molecular substance. The amount of such "produced" low molecular material is different in different grades of pulp. The degradation occurs in all fiber fractions and has obviously nothing to do with the cutting action of the beater. Nonglucosidic polysaccharides are more readily degraded than are the glucosidic. It is reasonable to assume that there is a connection between the production of low molecular material and the paper making properties developing during the treatment of the pulp in the beater.

In previous papers a method has been suggested, according to which information about the composition of wood pulps could be obtained from observations during nitration of the pulp, and dissolving the nitrates in acetone (Bryde and Rånby 1947, Bryde 1947).

The method was first applied to several series laboratory scale cooking experiments from which it was apparent that the method was capable of contributing extended knowledge about the chemistry of the pulping process. Particularly in studying the very first part of the cooking period, where the material still possesses the properties of a semichemical pulp the method proved to be useful (Bryde 1949, Bryde and Smith 1950).

In the investigations here to be described, the nitration method was applied to various fiber fractions obtained by passing pulp through a Bauer McNett Classifier. The determination was carried out on both nonbeaten and beaten pulp samples. This was originally done to learn if there were some connection between the heterogeneity of the fiber length and the heterogeneity in composition and molecular properties. During the study of the beaten samples the observations led the investigation in a somewhat different direction. So the last part of the paper will discuss if and to which extent beating performs cutting of polysaccharide molecule chains.

EXPERIMENTAL

The fiber fractionation was carried out by means of a Bauer McNett classifier provided with 20, 35, 65, and 150-mesh screens. A slight modification from standard procedure was introduced. According to this, the −150 mesh fraction was separated in a Hurum-Klem tester, previous to the classifier treatment. In this way the finest fraction was made available in higher concentration and could more easily be isolated. Details about the fractionation, and comparative experiments showing how the results deviate from standard runs, are published elsewhere (Bryde and Ellefsen 1951).

Fiber length measurements were carried out on all fractions, and according to Brecht and Mory 1934–35, at least 600 fibers were measured on each fraction. The results were recorded as frequency curves plotting $\Delta n_i l_i / \Delta l_i$ versus l_i(Δn_i = number of fibers with fiber lengths between l_i and $l_i + \Delta l_i$). The fiber length range of each group was taken to 0.05 and in some cases to 0.1 mm. Assuming that average weight of unit fiber length is independent of total fiber length, $\Delta n_i l_i$ will be proportional to the weight of the fibers in the ith group. Accordingly, by plotting $\Delta n_i l_i / \Delta l$ versus l_i, an expression for the frequency distribution of the various fiber lengths by weight is obtained (Graff and Miller 1939, Sommer and Henning 1950). When the curves for the various fiber fractions are plotted so that the area under the curve is proportional to the percentage of the respective fractions, the curves can be added and the resultant curve will express the fiber length distribution of the whole sample (Fig. 5).

The nitration method has been described in detail in previous papers (Bryde 1949, Bryde and Smith 1950), and only a brief review shall be given here.

The samples are nitrated with nitric-phosphoric acid according to Davidson 1938, and then thoroughly washed, first with 50% acetic acid, then with cold distilled water, succeeded by an extraction with methanol (Husemann and Schultz 1942). If samples containing a high amount of lignin are investigated, the methanol soluble part is isolated by evaporation of the methanol. As shown in Fig. 1, this fraction is called the C-fraction, whereas the material removed during nitration and washing is recorded as nitration losses.

When the method is applied to usual paper and rayon pulp grades, the methanol-soluble part is so small that the isolation of this fraction can be omitted. The methanol-soluble material is then counted together with the nitration losses. This has been the case with all samples in the present study.

According to Fig. 1, the next step is to dissolve the

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nitrates in acetone. Also this procedure provides the possibility of isolating part of the material as an acetone-insoluble fraction, which, however, also appears only in samples with very high lignin content, or in special cases in some hardwood pulps (Bryde 1949).

In the final operation, shown in Fig. 1, the acetone solution has to be poured into a large excess of water. Most of the material will then separate as a fibrous, cottonlike precipitate, whereas a minor part will remain in the water phase in some kind of a colloidal suspension. The precipitating part is called the A-fraction, and the nonprecipitating part the B-fraction. The latter can

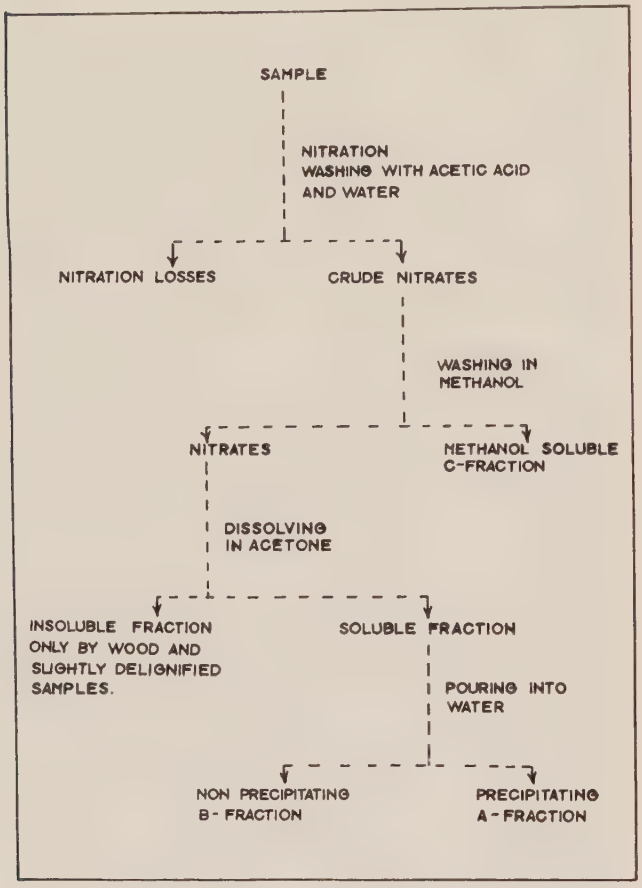

Fig. 1. Schematical presentation of the nitration method

be isolated by evaporating the water *in vacuo*. These two fractions are the only two considered in the present investigation. As far as it can be assumed that the nitration does not seriously attack the cellulose molecule chain, physical measurements in order to determine molecular weight, etc., can be carried out on the fractions.*

The fractions can then be denitrated (Dorée 1947) and hydrolyzed in order to give a solution of the composing monosaccharides. The constituents of this solution are found by paper partition chromatography using butanol-ethanol mixture as solvent according to Partridge 1946. The quantitative evaluation of the chromatograms is carried out by the periodate method of Hirst and Jones 1949.

* In order to prevent confusion, the term fraction alone is only used for "chemical fraction" in the sense it is used here. The fractions obtained with the classifier are consequently described as fiber fractions

THE APPLICATION OF THE NITRATION METHOD TO THE PRESENT PROBLEM

In order to be able to compare the results obtained with more common analytical results, the data of a

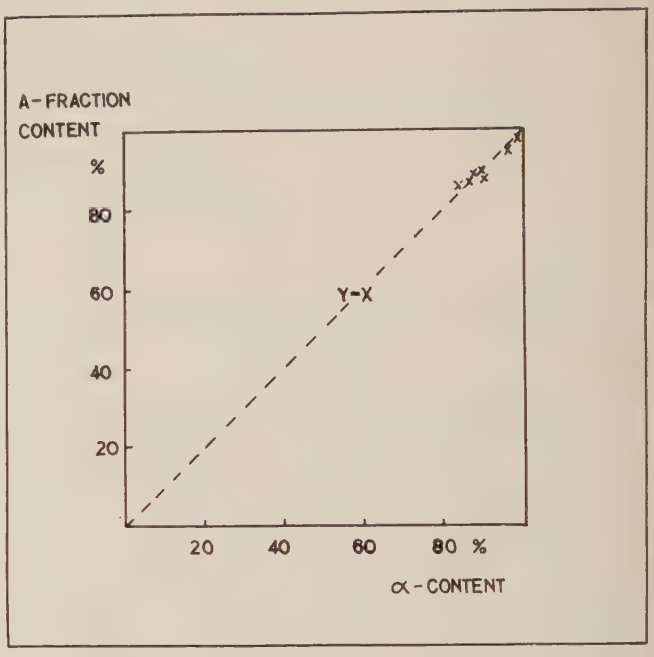

Fig. 2. Comparison between A and alpha content of commercial pulps

series of experiments showing the relationship between the A-content and the alpha-cellulose content are given below. The alpha-cellulose is determined according to

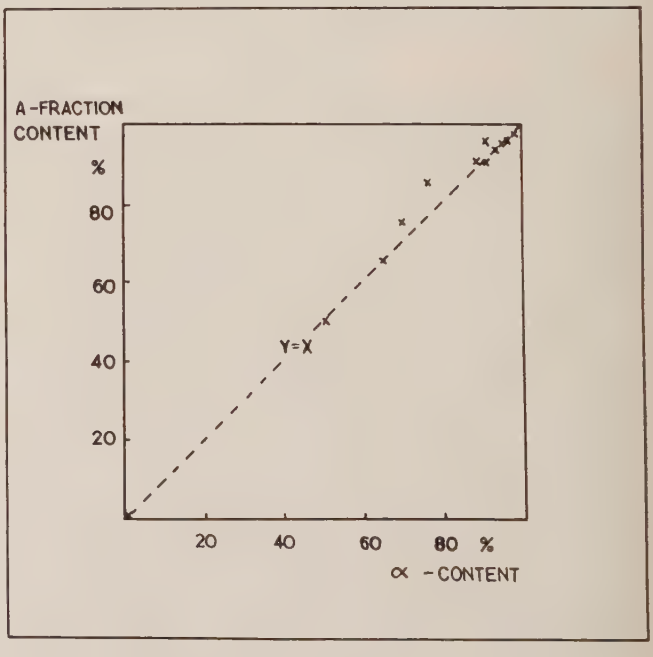

Fig. 3. Comparison between A and alpha content of hydrolyzed cotton linters

the Norwegian standard method (P.F.I. 1940), which gives results slightly higher than TAPPI 203 m-36.

Figure 2 shows a number of analyses carried out on

commercial pulps. As the range of variation in alpha content is rather narrow a series of similar investigations on partly hydrolyzed pulps carried out by Abadie 1951 is given in Fig. 3. As it will be seen, the A-content corresponds fairly well to the alpha content of the samples.

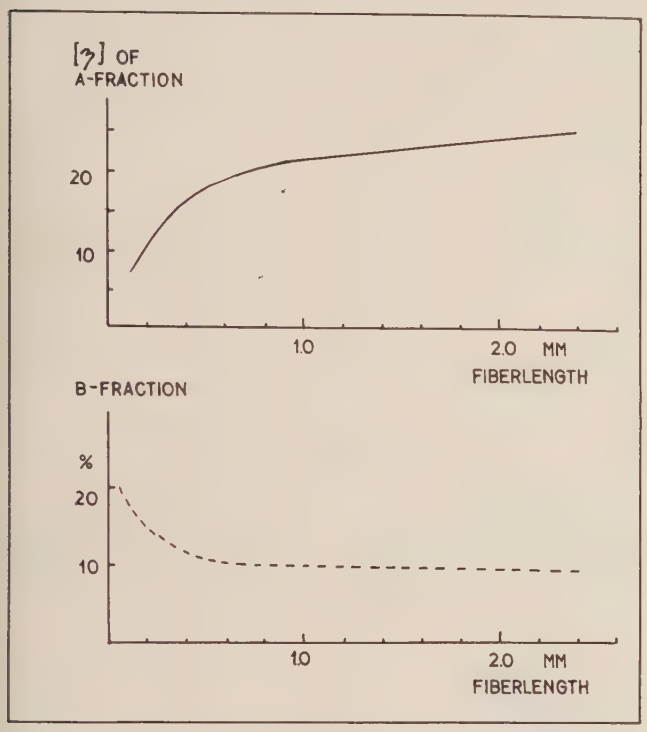

Fig. 4. Limiting viscosity number and B content versus fiber length

Now it may be questioned: Why use this tedious nitration procedure, when the same result can be obtained by a simple alpha determination?

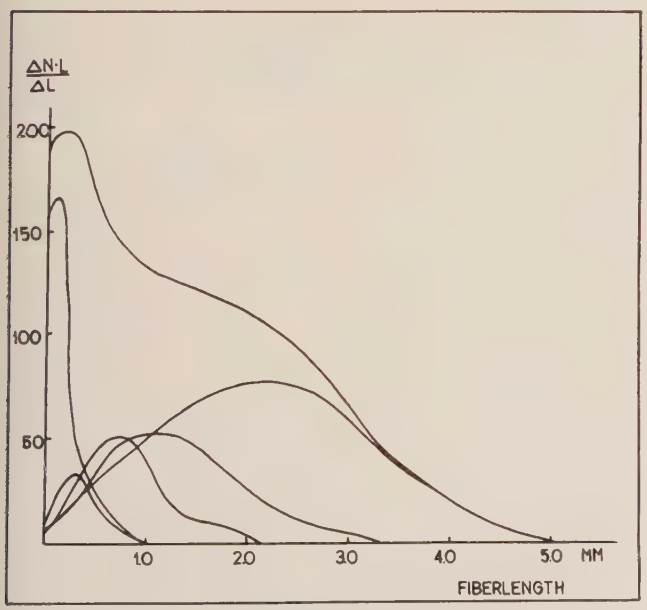

Fig. 5. Fiber length frequency distribution by weight of the fractions

The reason is first of all that both the A and the B-fraction can easily be isolated, and in such form that the D.P. of the components is approximately the same as in the pulp. Furthermore, the results are to a large extent independent on the experimental conditions during the isolation. Of particular importance in the present case is the fact that the results are not affected by the mechanical conditions of the pulp sample, provided though that this is present in such a form that it is accessible to the nitration liquor.

According to our original procedure, the samples were disintegrated on a dry defibrator. When beaten samples had to be investigated and the pulp dried in very hard lumps, the defibration became difficult. In some previous cases this difficulty had been managed by making the pulp into thin handsheets, which nitrate very well. This was for obvious reasons not applicable to the present case, particularly not when the finest fiber fractions were to be handled. Freeze drying of the samples was therefore tried with excellent results. A water suspension of the fibers was rapidly frozen in a test tube by means of carbon dioxide. The ice was then

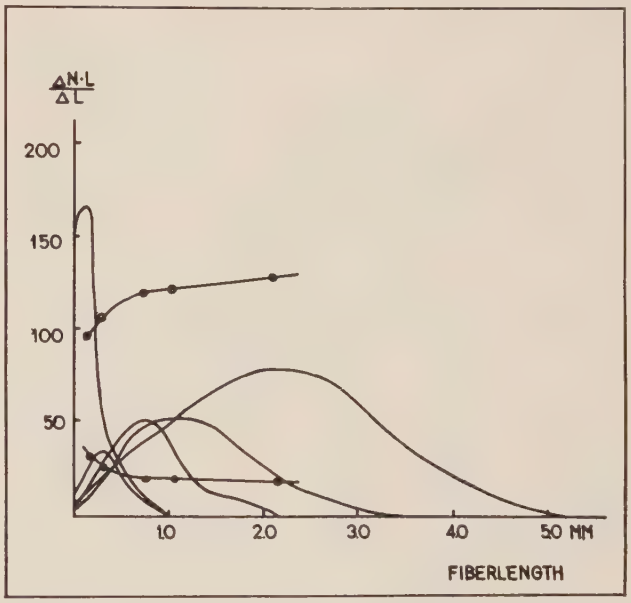

Fig. 6. Limiting viscosity number and B content of the fiber fractions plotted versus mode values of fiber length frequency curves

removed by sublimation in high vacuo leaving the fibers as a soft pad, even when highly beaten stock was treated. This pad had good accessibility to the nitration liquor. Also for other chemical treatment of cellulose freeze drying seems to provide a suitable way of preparing the samples.

A further advantage of the nitration method is that it does not apply only to bleached samples, but gives comparable results also with unbleached and even with semichemical pulps. This is not the case with the alpha-determination (Lapèze 1948).

At last it may be mentioned that the nitration method can be carried out on very small samples, and that the results are independent of the sample weight. Most frequently 1 gram of substance has been nitrated, but when the material was scarce, as was the fact with some of the fiber fractions, the whole procedure has been successfully completed with 0.2 gram.

THE RESULTS

The Investigation of Fractions of Nonbeaten Pulp

As has been mentioned before, the goal for this part of the investigation was to find out whether there is any connection between fiber length and chemical properties of cellulose fiber fractions.

For this purpose several analytical determinations have been carried out on fiber fractions from various pulps ranging from an unbleached glassine to a high alpha dissolving pulp grade. The results forming a mere recording of analytical data have already been published (Bryde and Ellefsen 1951), and shall be omitted here. The discussion shall be confined to the demonstration of two typical examples, one showing the limiting viscosity number $[\eta]$ of the A-fraction, the other showing the B-content, both plotted versus the fiber length (Fig. 4). The data originate from an unbleached

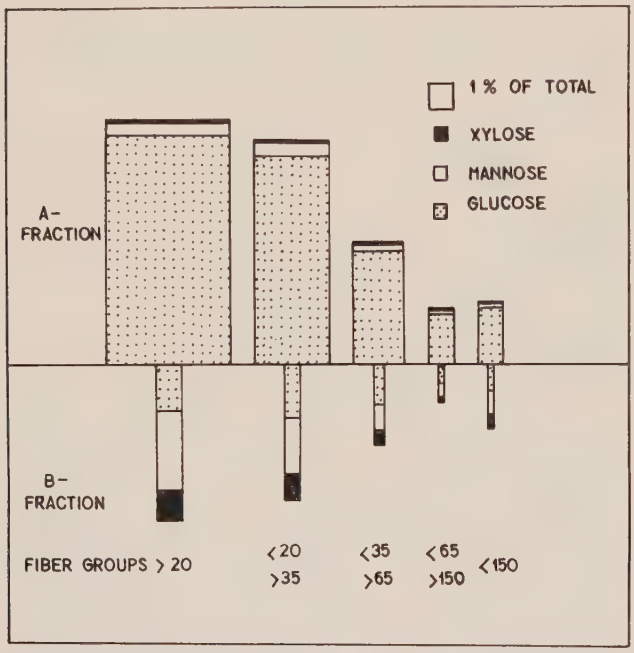

Fig. 7. Composition of the A and B material of various fiber fractions. The diagram is designed so that unit area expresses 1%

glassine pulp. The results from the viscosity measurements are in agreement with observations of Holtan 1940.

Before the curves can be discussed, it is necessary to define more strictly what is meant in this case: "plotted against fiber length."

In Fig. 5 the results of the fiber length measurements of the fiber fractions are plotted together to form the resultant frequency distribution curve for the whole sample. It is evident that the properties measured for one fiber fraction are very far from being representative for one well-defined fiber length.

Therefore, when in the following the mode value of the fiber length is taken as the abscissa value for the corresponding fiber fraction, this is a crude approximation. In Fig. 6 the curves from Fig. 4 are redesigned

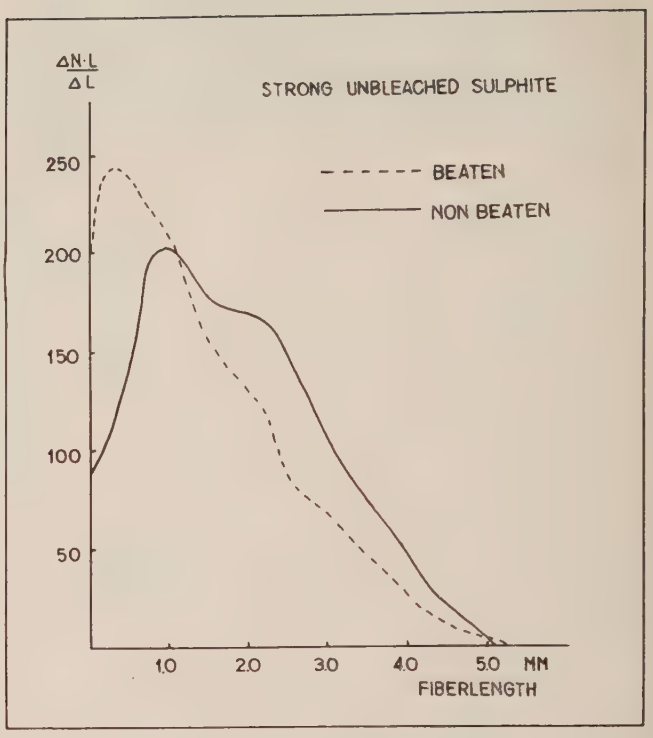

Fig. 8a. Fiber length frequency diagram before and after beating. Strong unbleached pulp

over the frequency diagram to show how the curves are constructed.

It will be seen that both curves consist of one almost level part connecting the fractions +20 to +150, and one steeper part connecting +150 with −150. There is no

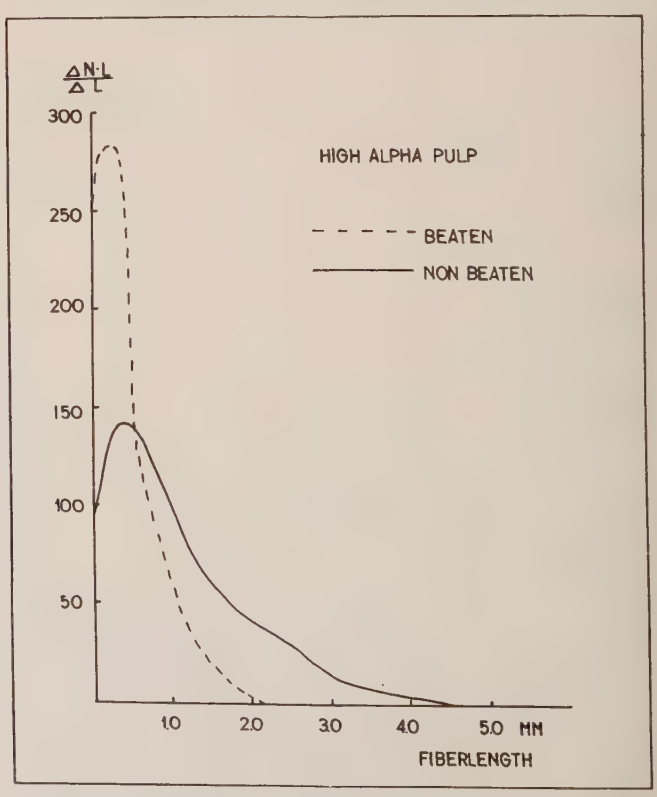

Fig. 8b. Fiber length frequency diagram before and after beating. High alpha pulp

doubt that the difference in properties between the very short fibers, and the more lengthy ones, is real. The regression in the less inclined part of the curve is, however, dubious. From the frequency diagram it

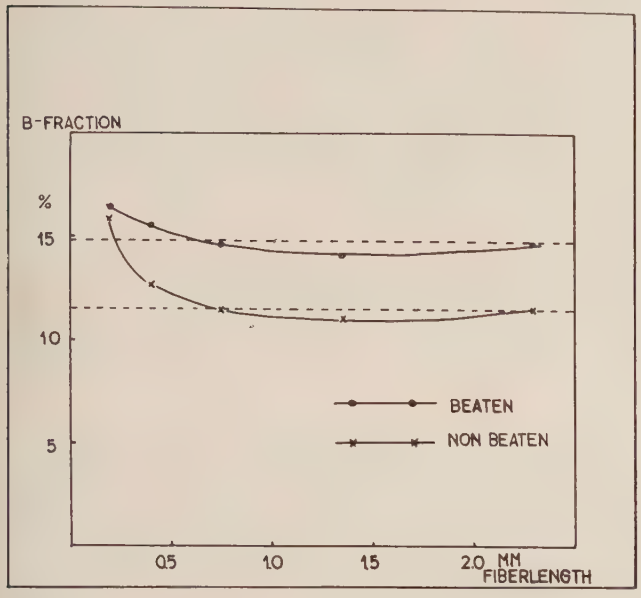

Fig. 9. B content versus fiber length before and after beating to 45°S.-R. Strong unbleached sulphite pulp. The horizontal dotted lines show the total amount of B material in the samples

appears that all fiber fractions, even the longest, contain some of the shortest fibers. The percentage of this part decreases with increasing fiber length. Consequently, the slope of the more level part may very

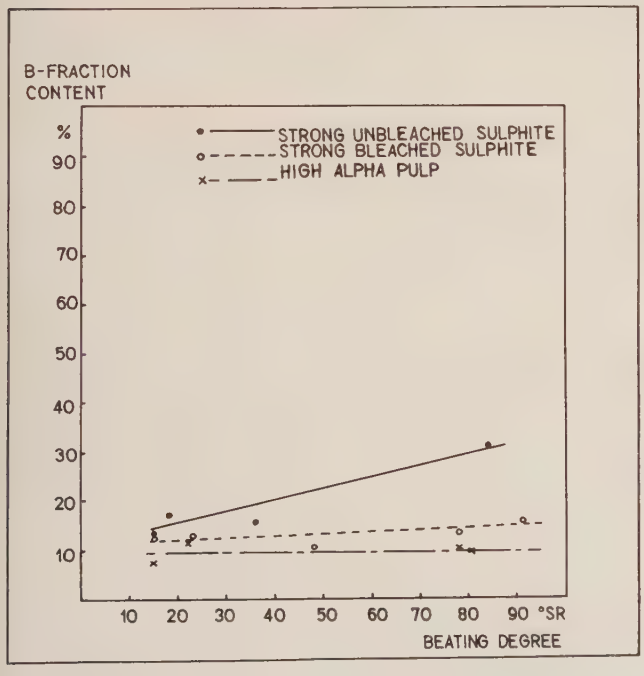

Fig. 10. B content versus beating degree. Three different grades of pulp

well express nothing but the influence of the short fiber content on the average properties of the respective fiber fractions.

It is not possible to verify this on one single experiment, because the sources of errors will predominate the actual effects. But if all measured properties of all samples are taken together and treated statistically, it can be shown that there is evidence for the assumption, that types of fibers with distinctly different average chemical properties are present in the wood. The statistical treatment has been published elsewhere (Bryde and Ellefsen 1951).

From a botanical point of view the two component hypothesis appears reasonable recalling the existence of the short parenchyma and the longer prosenchyma cells which may very well be differently composed. The investigated material is, however, not very well suited for extending the conclusions so far back as to the botanical origin of the samples. This is because all the pulps studied are commercial grades, and it has been shown by Bergman and Backman 1929, that commercial pulps always contain some very short fragments of prosenchyma cells, damaged during chipping, or other mechanical handling in the mill.

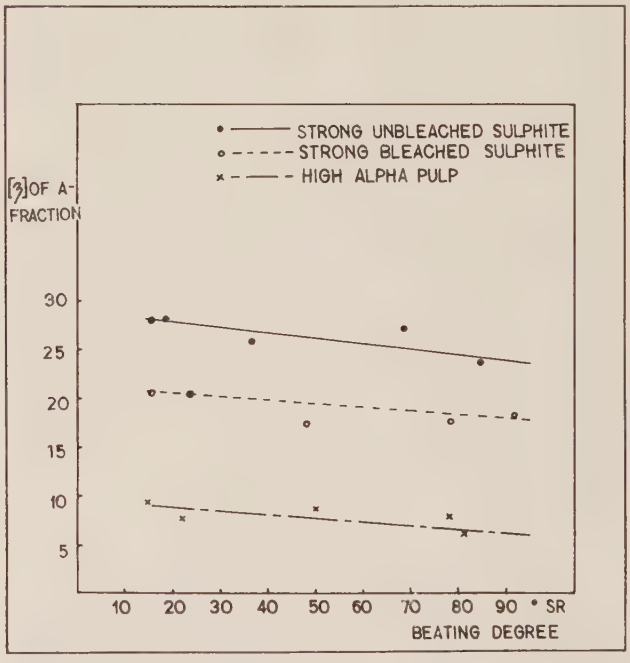

Fig. 11. Limiting viscosity number versus beating degree for same samples as in Fig. 10

The results of the chromatographic determination of the composing sugars of the A and B-fractions from various fiber fractions of the glassine pulp shall be shown in Fig. 7. The lack of accuracy of the methods does not allow any conclusion to be drawn from this result, and the diagram must be considered only as a recording of the observations.

The Investigation of the Beaten Material

The pulps were beaten on the P.F.I. laboratory beater described by Stephansen 1948.

When the material was to be run on the classifier, the pulp was beaten to 45 ± 2°S.-R. More beaten pulp has shown a tendency to flocculate in the classifier, thus obscuring the separation (Steinschneider, Kross, and Irmgrund 1936, Stephansen 1950).

The action of the beater is considered to be partly a shortening of the fibers, partly a quenching which changes the properties of the fiber surface. The shortening or cutting action of the P.F.I. beater is not very expressed, but as will be seen from Figs. 8a and b, showing the fiber length frequency distribution diagrams of two samples before and after beating, some transfer of material from the higher to the lower fractions has taken place.

The preassumption was that the study should decide between two possible ways of the pulp to behave during beating. Hence it was expected that either all fibers may have the same chances to be attacked, or some fibers discriminating themselves by particular chemical properties may be more readily cut than the others.

Assuming that the beating had no effect on the chemical properties as such, the comparison of the properties of the fractions before and after beating should be able to tell if the material converted from the long to the short fiber type had the average properties of the long fibers or not.

On this background the results, as they gradually appeared, were rather surprising. A typical pair of curves showing the B-content before and after beating is shown in Fig. 9. This way of presenting the results may be confusing, because the various points represent very different amounts of material.

This may particularly give misleading impressions if the curves are crossing each other. In this case, however, where the curve for the beaten material shows an increase in the B-content for all fiber fractions, there is no doubt about the conclusion that the B-content has really increased during beating. This indicates that the beating has attacked the long chain molecules forming some low molecular material. It is also obvious from the curves that this molecular attack is not connected with the cutting of the fibers, because the B-content has increased in all fiber fractions.

If the beating has attacked the cellulose in such a way that new low molecular substance is formed, one may also expect to find some decrease in the viscosity of the A-fraction because all attacked chains may not immediately have been cut so far as to the molecular size of the B material. This was found for some of the samples but not in consequent correspondence to the increase in the B-content.

In order to get additional information about this degrading effect, samples of three different grades of pulp were beaten to various beating degrees. From each sample the total material was nitrated, and the B-content and the limiting viscosity number of the A-fraction were determined. The results are shown in Figs. 10 and 11.

The strong, unbleached pulp, being a typical glassine quality, has a marked increase in the B-content. For the strong, bleached pulp, which is supposed to be a typical writing quality, some increase in the B-content may be recognized, whereas in the last sample, a high alpha rayon grade, apparently no B substance is produced during beating.

The results from the viscosity measurements are less typical. The occurrence of a slight decrease in viscosity with increasing beating degree seems to be confirmed, but no significant difference in the slope of the curves for the various samples can be concluded.

It was known, prior to these findings, that the effect of the beating on the pulp viscosity is made subject to a comprehensive study in the Swedish Forest Products Research Institute (Almin 1951). Further efforts in order to investigate this part of the problem were postponed in the expectation of the results of Almin.

The formation of B material in some of the samples appeared worth while investigating. It can be deduced from Fig. 10 that the formation of B material is highest in the less purified cellulose, and practically none in the high-grade alpha sample. This may indicate that the nonalpha material is much more readily attacked than is the alpha-cellulose. In order to study this, denitration, hydrolysis, and chromatography runs were carried out on the B material before and after beating, and as a comparison also on the A material of the nonbeaten sample.

From the difference between the analyses "before" and "after," the composition of the "produced B material" could be computed. The accuracy of such indirect determination is poor, and in cases where the amount of produced material is low compared with the original B-content, the computed figures will be quite erroneous.

In Table I results from this investigation are shown.

Table I. Composition of Fractions

	Bleached sulphite			*Strong unbleached sulphite*		
	Glucose, %	*Mannose, %*	*Xylose, %*	*Glucose, %*	*Mannose, %*	*Xylose, %*
B-fraction before beating	67.0	29.7	3.3	35.5	45.0	19.5
B-fraction after beating	58.3	32.3	9.4	37.0	50.5	12.5
B-fraction formed by beating	36	39	25	35	54	11
A-fraction	94.0	5.0	1.0	95.0	4.5	0.5

Even if allowance is made for considerable errors in the calculated values, it is obvious that the composition of the B-fraction formed deviates very much from the composition of the A-fraction, i.e., the fraction from which it is formed.

CONCLUSION

During beating some of the higher molecular polysaccharide material is attacked, forming substances of a lower molecular weight. All composing polysaccharides seem to suffer some attack, but the nonglucosidic polysaccharides are more readily broken down than are the celluloses. The degradation is not connected with the cutting of the fibers in the beater, but appears in all fiber fractions.

The tendency to form low molecular material during beating is particularly expressed in glassine pulps. It is possible that the formation of a glassy stock is due to the amount of low molecular material formed. As the low molecular material is still part of the fiber structure, and occurs on all fibers, this assumption agrees with the observation that if a stock is beaten to form a glassine sheet, and then fractionated on the classifier, all fractions, even the longest, will produce glassine sheets (Stephansen 1948).

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New Developments in Recovery Unit Design

F. W. HOCHMUTH

It is generally agreed that the prime function of the recovery unit is the recovery and conversion of the sodium salts which are present in the black liquor produced in the digesters. A secondary but equally important function is the efficient recovery of heat from the combustible portion of the black liquor in the form of high-pressure, high-temperature steam. Since a furnacing operation is required to carry on the chemical recovery portion of the process, the burning of the black liquor solids is a prerequisite to the entire operation. The recovery and conversion of the chemical ash occur on the hearth and in a small portion of the furnace directly above the hearth. The design problems in this section are primarily those of providing a durable structure which will serve as a hearth for the burning of the combustible matter from the dry solids and the smelting and reduction of the sodium salts contained therein. Actually the major portion of the recovery unit equipment concerns itself directly with fuel burning and steam generation. Because of this, the design problems involved in a recovery unit are mainly those of fuel preparation, combustion, and heat recovery.

It is the object of this paper to discuss the equipment required to carry on the above operations. No special attempt will be made to describe the general scheme and theory of recovery unit operation since that subject appears to have been adequately covered in other papers.

EVOLUTION OF THE PRESENT DESIGN

The present-day CE-S recovery unit is the result of progressive changes imposed upon the basic designs that were developed during the period between 1937 and 1940. It was at that time that the concept of the tall vertical towerlike furnace was introduced together with a boiler and superheater arrangement which made full recognition of the extreme slagging problem that exists when burning kraft process black liquor. As a result a recovery unit was developed wherein the deposition of ash and slag on the heating surfaces was held to a minimum. Furthermore, the arrangement of these surfaces was such that the removal of these deposits was greatly facilitated and the return of these deposits to the furnace made simple and direct. This design also had the inherent feature of being capable of being reproduced in large sizes without sacrificing the operating advantages which were so apparent in the capacities for which it had been originally designed. Without a doubt it laid the foundation for the large capacity recovery units which are in common use today. For those who are interested a detailed account of this important development can be found in a paper previously presented before this Association by Rosencrants (*1*) in 1941.

As a testimony to the advanced thinking and sound design that went into these original units one need only examine the recovery units that are being furnished the pulp and paper industry today. The idea of the tower furnace has been universally accepted as has been the basic arrangement of the boiler, furnace, and superheater. Figure 1 shows a cross section through the first unit built of its type and the forerunner of the present-day recovery unit. It was first placed in service in January, 1938. In this unit it will be noted that the lower furnace was contracted so as to provide a hearth having an area smaller than the cross section of the main furnace. This was done since it was thought necessary to maintain a certain minimum heat release in this section in order to insure stable combustion. The upper furnace walls were not completely water cooled and were composed of 3-in. tubes on approximate 15-in. centers. The superheater was installed between the screen and first boiler bank but with a baffle separating it from the furnace. A two-drum, vertically baffled boiler having a bottom gas outlet was used, and the boiler was followed by a gas air heater. A cascade evaporator was installed after the air heater in order to provide for concentrating the liquor up to 65% solids, that being the solid content required for best furnace operation.

The second unit shown in Fig. 2 was placed in service in February, 1940, and is similar to that shown in Fig. 1. However, certain important changes were incorporated to take advantage of the experience obtained from the operation of the first unit. The lower furnace was not contracted since it had been discovered that was unnecessary. In order to secure more heat absorption in the upper furnace and reduce the maintenance which had resulted from the exposed refractory, this section was made completely water cooled by adding continuous fins to the wall tubes and spacing them on closer centers.

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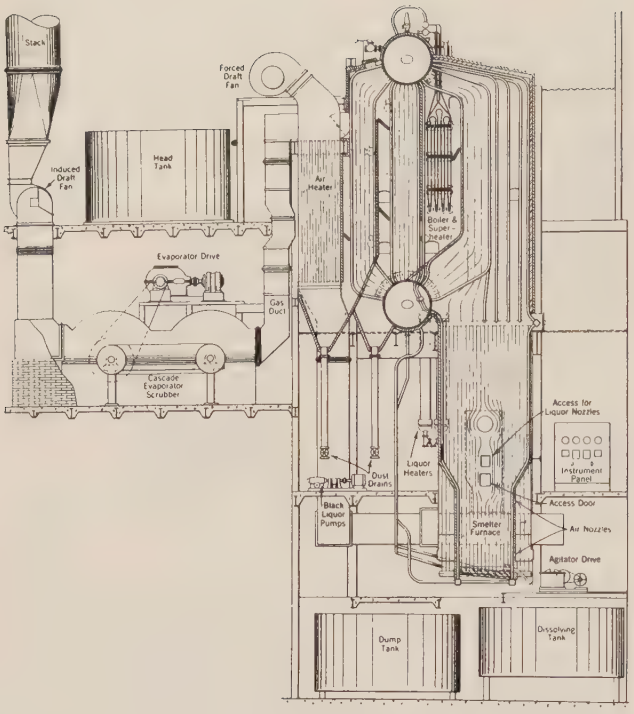


Fig. 1. First vertical tower-type unit placed in service January, 1938

The superheater was moved forward so that it was directly over the furnace. An additional drum was added so as to permit a simple method of terminating the upper furnace wall tubes and to make it unnecessary for the screen tubes to cross over through the superheater in order to enter the boiler drum. The arrangement of the two upper drums allowed the roof tubes to be spaced so that the upper bends of the superheater could be placed beyond the roof and yet keep the superheater, screen, boiler, and front wall tubes all in line so as to permit unobstructed lancing from front to rear. The superheater and screen tubes were also kept in alignment with the side wall tubes so that all of the heating surfaces above the furnace could be lanced either from the front or from the sides. With this arrangement not only was it possible to clean the superheater and screen with greater ease than before but the heavy, hard deposits removed by the lancing operation would fall directly down into the furnace where they would melt and drain from the furnace along with the smelt. The gas air heater was eliminated and a steam air heater used instead. In place of handling the dust from the boiler hoppers dry, as had been done on the original installation, a wet handling system was developed. In this system a stream of recirculated wash liquor was directed into the bottom of the ash hoppers so as to flush the ash to a small dissolving tank, this solution being bled off to the cascade evaporator thereby allowing the chemical dust to return to the furnace along with the black liquor being burned.

Figure 3 is a sectional perspective drawing typical of the recovery units which have been built in the last few years. In order to satisfy the requirement established by a general increase in the density of black liquor from the multiple effect evaporators a large economizer has been included to reduce the gas temperature to the desired level. Although not shown in the figure the provision for cleaning the heating surfaces has been greatly expanded so as to reduce operating labor. The strategic use of mass blowing, retractable units together with either steam, or intermittent air blowing, revolving units, has greatly decreased the amount of hand labor required to keep the heating surfaces clean and the gas passages open. Special attention has been devoted to the design of the various heat-absorbing sections so that full advantage can be realized from the soot blowing equipment. This point will be discussed in greater detail later in this paper. Figure 3 also illustrates the close integration of the recovery unit boiler and furnace with respect to its auxiliaries and the building framework. Throughout the development of this equipment special attention has always been given to creating an arrangement which would be highly functional, provide ample space for operation, and still be consistent with economical building design.

TREND IN DESIGN CONDITIONS

Prior to 1937 the largest capacity recovery unit that was available had a capacity of 390,000 lb. of dry solids per 24 hr. Assuming a nominal value of 3000 lb. of black liquor solids per ton of capacity this unit would be designated as a 130-ton recovery unit. Since 1937 the capacity has increased steadily and at the present time there is at least one unit in operation having a design capacity of 1,140,000 lb. of dry solids or 380 tons. Figure 4 is a chart showing how the recovery unit capacity has increased between the years of 1939 and 1951. This chart indicates the capacity of the largest individual unit in operation for the years indicated.

As a result of the large capacity recovery units now available there has been a definite trend to single-unit installations in mills having up to 400 tons of capacity.

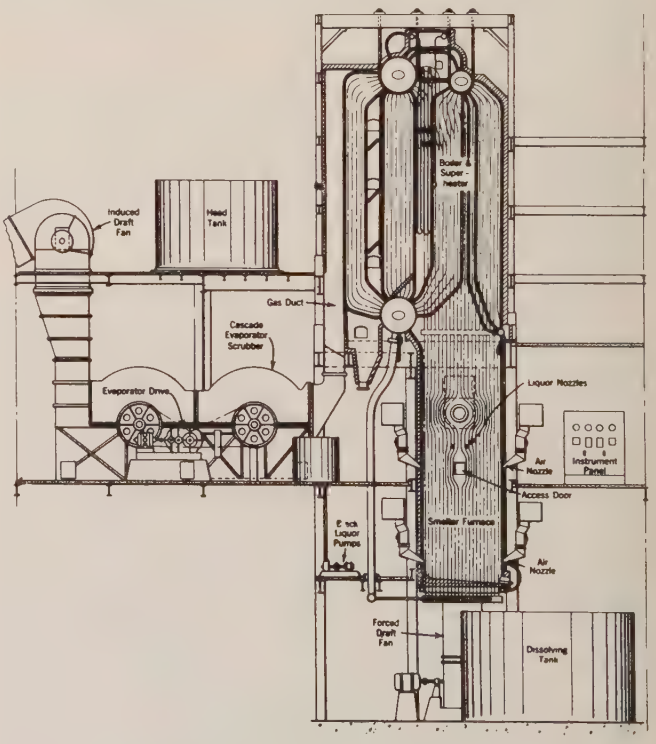


Fig. 2. Improved vertical tower-type unit placed in service February, 1940

This is a natural consequence since a single large unit installation allows a sizable decrease in capital cost over an installation where two units would be installed for the same total capacity. Not only is the capital investment considerably less but also the direct cost of operation and maintenance for a single large unit is only little more than half of what it would be on two units. In those cases where single-unit installations have been made the reliability of those installations has been excellent. In most instances the recovery unit has an availability which is equal to or greater than any other major piece of equipment in the pulping process.

The first large, single-unit installation was proposed in 1946. This unit had a design capacity of 960,000 lb. of dry solids per day, or in other words, was a 320-ton unit. Operation of this unit began early in 1949 and it has been in continuous service since on the basis of four scheduled shutdowns per year. Although there have been some forced outages during this period none of them have been of serious nature.

In addition to the increase in capacities, there has been a trend to higher steam pressures and temperatures. These increases in pressure and temperature are shown on Fig. 5. The values shown represent the maximum conditions of pressure and temperature prevailing during the periods indicated. This constant increase in steam pressures and temperatures has followed the requirements established by the mill designers wherein their heat balances call for increasing the amount of power available from the steam required by the process.

IMPROVEMENTS IN SUPERHEATER DESIGN

A recent development in recovery unit design has been the rearrangement of heating surfaces in the superheater. Because of the large percentage of ash contained in the black liquor solids and the low fusion temperature of this ash, slagging of the heating surfaces has always been a major problem in recovery unit design. Although this problem is also encountered in conventional steam generator design, it is much more acute in a recovery unit since in this case the ash has a softening temperature of approximately 1400°F. instead of 2000°F. which is typical of the ash from low quality bituminous coal. With the introduction of larger recovery units this problem became more serious since the greater physical dimensions of these units made it more difficult to clean the heating surfaces by hand lancing. Furthermore, steam temperatures were increasing, thereby requiring larger superheaters and higher gas temperatures entering these superheaters.

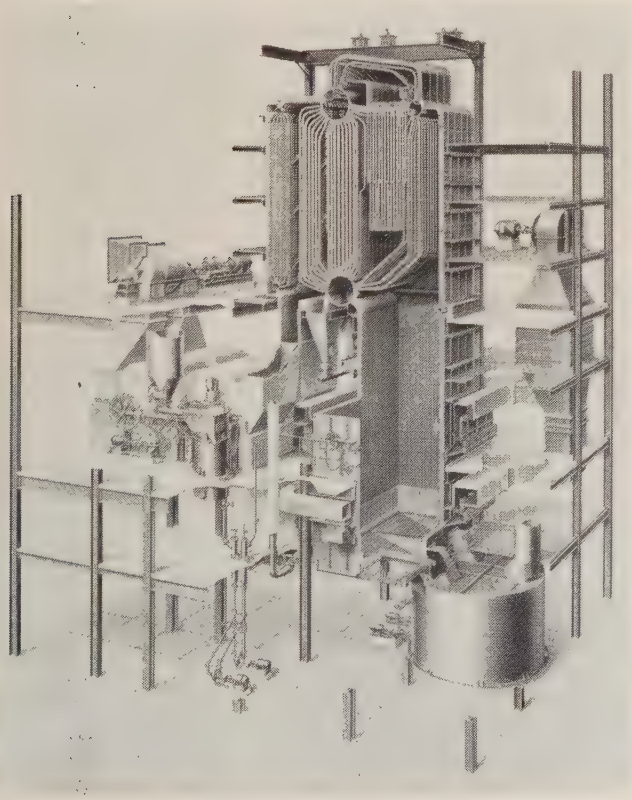


Fig. 3. Typical recovery unit of recent design

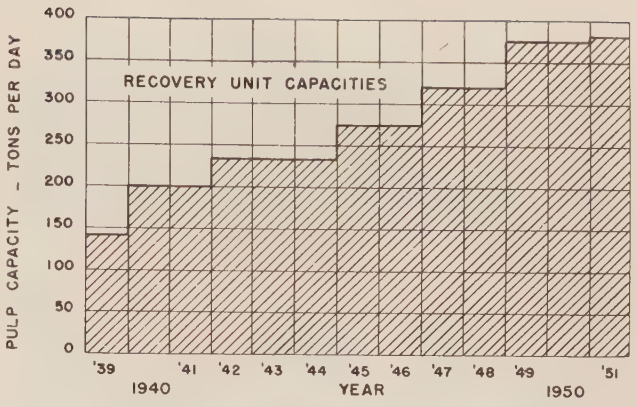


Fig. 4. Trend of recovery unit capacities

About 5 or 6 years ago the use of mass blowing retractable soot blowers for cleaning the superheater became common practice. Originally it was hoped that these blowers would be able to handle the complete job of slag removal and make it unnecessary to do any hand cleaning in this section. Unfortunately these soot blowers were not able to perform a complete cleaning job and therefore it was necessary to retain the practice of hand lancing to remove those deposits which could not be removed by the soot blowers. Experience proved that the soot blowers were able to remove the dry porous deposits but were less effective on sintered deposits and were of no practical value on slag which had gone through a molten state. It was apparent that if the need of hand cleaning in the superheater was to be eliminated it would be necessary to provide some sort of a superheater surface that would be less susceptible to slagging and furthermore, that this surface would permit the easy removal of the slag that does collect.

In studying slag deposits in standard superheaters it was noted that the spacers required by this design to hold the tubes in position served as anchors for any slag that was formed. These spacers also encouraged the formation of slag since their temperature would be higher than that of the adjoining superheater tubes. This higher metal temperature caused molten ash to appear on the spacers even though the gas temperatures were not high enough to cause slag to form on the superheater tubes. Another observation was that with open spacing of the superheater tubes slag was very difficult to remove once it circled the tube. Even after plastic slag was permitted to solidify by shutting down or by

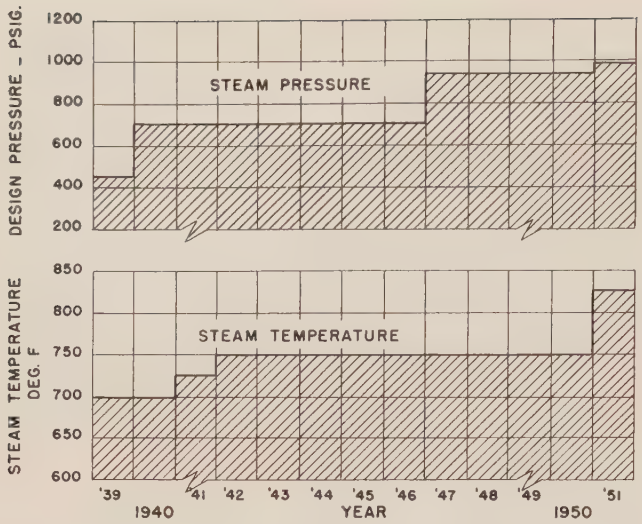


Fig. 5. Trend of recovery unit steam pressures and temperatures

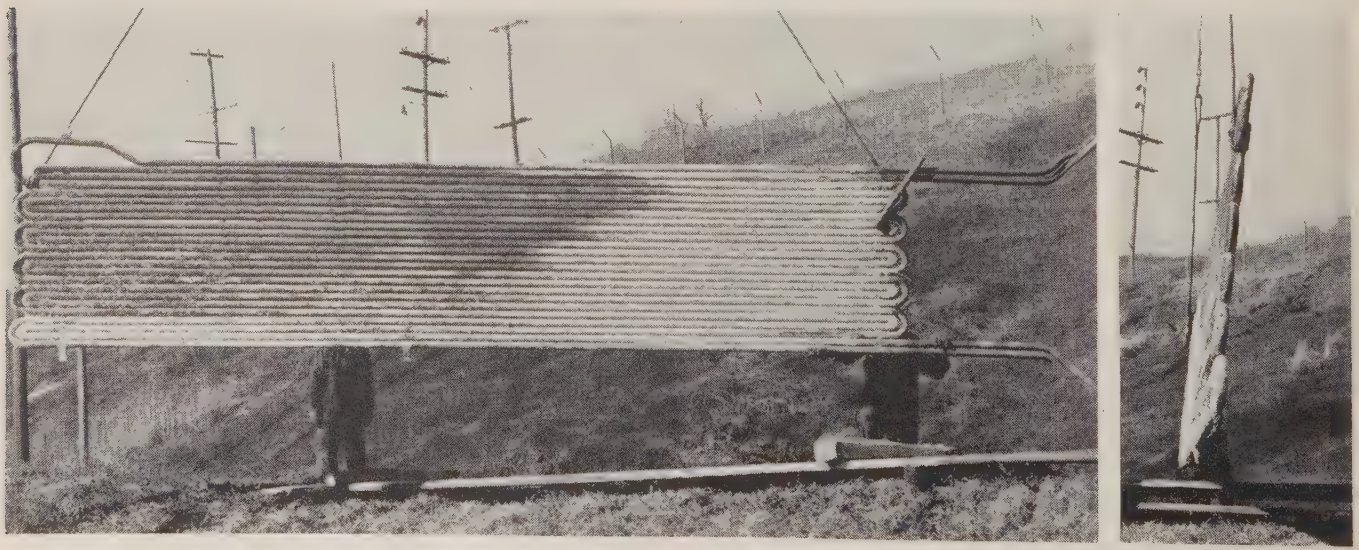
reducing rating, any formation encircling the tubes could only be removed by striking them hard enough with a lance so that the ring would be fractured and the keying action destroyed.

With the preceding observations in mind it became apparent that a considerable improvement could be made in the superheater if the spacers were eliminated, and a type of surface provided which would prevent keying of the slag. After some consideration it was decided to develop a superheater element which would consist of a row of tubes placed tangent to each other so as to form a platen. Each element would contain as many tubes and circuits as required to secure the necessary heating surface and pressure drop. Since the tubes had to be held in line by some means it was decided to weld adjacent tubes to each other so that each element was held together at several points by a line of welds running from the front tube to the rear tube. This type of construction eliminated most of the spacers and guides previously required except those used at the front and rear of each element for holding the superheater in line with the boiler and screen tubes. On a 350-ton unit, with a superheater designed for 750°F. steam, this reduced the number of spacers by at least 90%.

The arrangement of tangent tubes resulted in a final surface which presented a relatively smooth surface to the gas stream. This provided a desirable surface insofar as minimizing the amount of ash deposited on the surfaces by impingement. Although some of the deposits on the superheater surfaces result from the condensation of sodium salts from the gas stream it is the general opinion that most of the ash is deposited by impingement of material carried in the gas stream.

Since all tubes in each element contact the adjoining tubes it is impossible for any slag formations to key on to individual tubes. Any slag sheath that forms must encase the entire element from front to rear. On first thought it appears that this condition might be just as troublesome as the original arrangement of tubes on open spacing, however, experience with an actual installation later proved that such was not the case. Apparently when the slag is formed in large sheets on the platen elements fracture points occur in the sheath which permit the soot blowers to strip the slag from the platen. These fractures in the slag sheath are probably caused by differential expansion occurring between the slag and the superheater elements, this expansion difference resulting from changes in gas temperature and variations in the average steam temperatures of individual superheater elements.

In order to obtain some preliminary information three test platens were made up and installed in an existing recovery unit. This unit was a 200-ton unit with steam conditions of 425 p.s.i.g. and 700°F. The three test platens were installed in the center of the existing superheater by removing a number of the existing standard elements. The platens were spaced 12 in. from each other and 12 in. from the adjoining standard type elements. The purpose of the test installation was to develop heat transfer data on this type of surface and to determine if slag deposits would be reduced and their removal made easy. The test installation would also be used to check the mechanical construction and determine if any element warpage would result from the rigid construction employed in joining the tubes.



Figs. 6 and 7. Test platens after removal from service

The test elements were installed and kept in operation for approximately 4 mo. During that period the recovery unit was operated at 138% of its design rating for most of the time. Since this unit was not equipped with retractable blowers in the superheater section a large nozzle hand lance was used for cleaning the test platens in order to simulate the action that would have been obtained had soot blowers been installed. The observations made during this period were favorable and an inspection of the elements after their removal showed them to be perfectly flat and in excellent condition. Figure 6 is a photograph of one of the test platens. This photograph was taken after the test platens had been removed from service and shows the element suspended horizontally instead of vertically as was its position in the recovery unit. A photograph looking at the bottom end of the element is shown in Fig. 7. This shows the element is perfectly straight with no sign of warpage.

Because of the favorable results obtained with the test platens a complete platen superheater was included with a recovery unit to be installed for one of the southern mills. The design capacity of this unit was 1,140,000 lb. of solids per day (380 nominal tons), with steam generated at 425 p.s.i.g. and 750°F. The superheater was installed in the same location as would be used for a standard superheater over the furnace and between the screen section and the first boiler bank. The platen elements were spaced on 12-in. centers across the width of the furnace and were suspended from above by the inlet and outlet terminal tubes. Each element contained three separate steam circuits, this arrangement being required in order to provide satisfactory pressure drop conditions. Figure 8 illustrates this arrangement showing the platen elements and the adjoining screen and boiler tubes. Mass blowing retractable soot blowers for cleaning the superheater were installed at four locations. Due to the width of the unit each of these locations was double sided. Two of the blower locations were in front of the superheater and two located behind. One fixed rotary-type

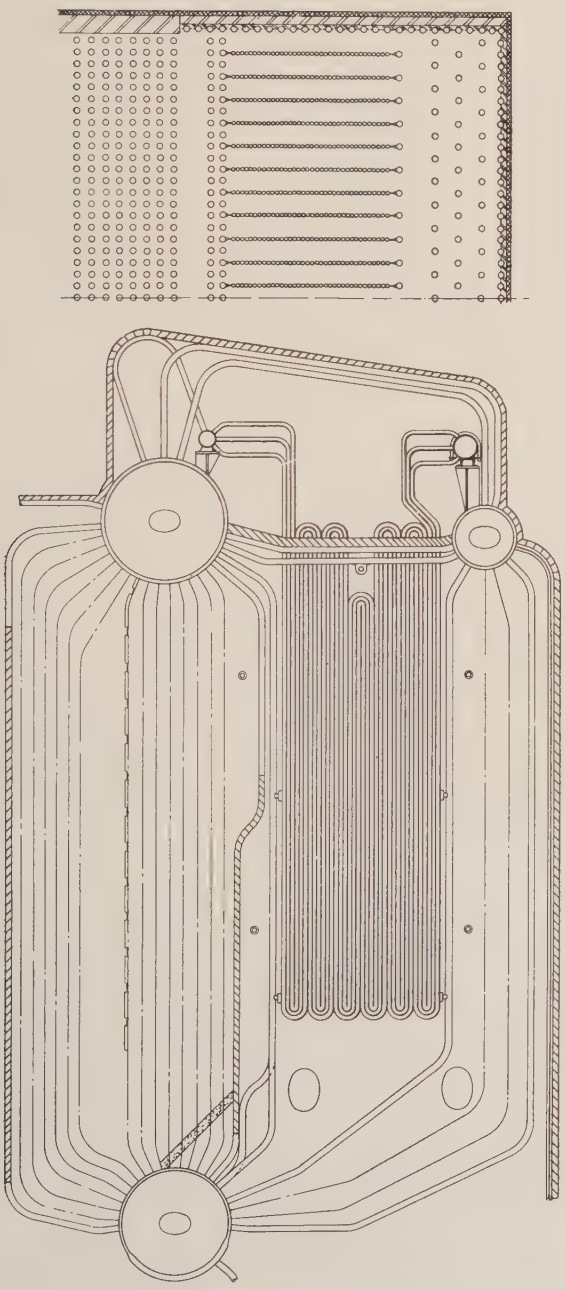


Fig. 8. Section showing platen superheater installation

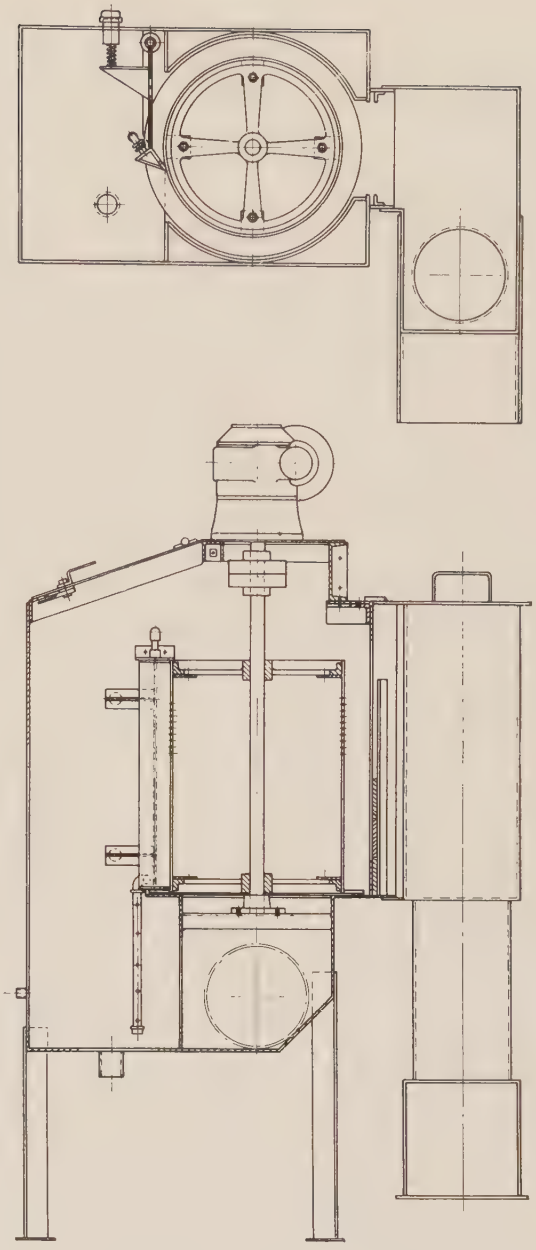


Fig. 9. Black liquor flow box and screen

steam blower was installed at the top of the superheater. The two retractable blowers in front of the superheater also served to clean the screen tubes and the top rear blower served the top section of the first boiler bank.

Early in 1952 erection was completed and the unit placed in operation in April. Steam temperatures leaving the individual elements were checked by means of thermocouples peened into the outlet tube terminals. Temperature data taken at this point indicated satisfactory temperature uniformity which, in turn, indicated uniform gas distribution through the superheater. No observation doors had been placed in the side walls opposite the superheater since they would have been of no value due to the solid construction of the platens. However, a complete row of lancing doors had been installed at three elevations across the front of the unit so exploratory lancing could be done in the superheater. Probing through these openings indicated that the sootblowers were doing a satisfactory job of keeping the superheater clean. The unit was shut down several times within the first 2 months of operation and a gas side inspection of the heating surfaces indicated that advantages anticipated for the platen surfaces were being fully realized. It should be mentioned that on one of the shutdown inspections a shelflike formation of slag was found extending across the lower section of the superheater. This slag shelf was from 12 to 18 in. thick and had bridged between adjacent superheater elements. Just what conditions led to this slag condition was never definitely determined but it had occurred during a period when there was some reason to believe that the sootblowers were not being used effectively. After the slag was removed the unit was placed back in service and since that time there has been no recurrence of this trouble. The unit has now been operating for 7 mo. and except for the one instance described had had no slagging trouble in the superheater. During this time no hand lancing has been done in the superheater and the only cleaning done in that section has been performed by the retractable sootblowers. For several months during this period the unit was operated at considerable overrating, 122% of rating being maintained for weeks at a time.

Besides the elimination of labor for hand lancing, an important secondary advantage obtained is an improvement in the upper furnace side wall settings and casings. This is due to the elimination of the many lancing doors that had been required by the standard design. The elimination of these doors allows the setting and its insulation to be continuous thereby insuring low casing temperatures and reducing maintenance in these areas.

It has long been the goal of recovery unit designers to develop a recovery unit which could be operated without resorting to routine hand lancing. The introduction of the platen superheater has been a great stride toward that goal. Only the lower portion of the screen pass remains a problem, that being the only section still requiring some hand cleaning. It is hoped that a solution for that condition can be developed within the near future.

FLASH DRYING IN THE FURNACE

Because black liquor is handled as a liquid all through the process, up to and including the point of injection into the furnace, it is usually thought of as a liquid fuel. However, before burning can begin the liquor must be reduced to a solid particle essentially free of all moisture. In most recovery systems this stage of drying is done within the furnace although it can be carried out separately. In the CE-S system of chemical and heat recovery this final stage of evaporation is obtained in the furnace by use of the principle of flash drying.

In this system the solids in the black liquor to the furnace are maintained as high as practical and still retain the black liquor in a fluid state. By experience it has been determined that these conditions are best satisfied when the solids content of the black liquor being fired falls within the range 65 to 70% solids. The exact figure depends on the character of the liquor being handled, a low viscosity liquor being concentrated to 70% solids and the higher viscosity liquors taking the lower value.

Direct contact evaporators of the cascade type have proved to be a very reliable means of securing these high liquor concentrations. This stage of evaporation is introduced between the multiple effect evaporators and the outlet of the waste heat boiler and utilizes the heat contained in the hot flue gases. Because of the direct contact principle, an evaporator of this type lends itself ideally to the final step of heat recovery where the heat head is necessarily low. One of the outstanding features of this type of evaporator is its uniform and dependable performance. The evaporation rates are not affected by dirtiness since evaporation proceeds directly from the surface of the liquor and not by transfer through a tube wall or other material. A fresh and uniform evaporating surface is presented to the gas stream and every revolution of the wheel. The draft loss through the evaporator is low and because the wheels are being continually washed by rotation in a bath of black liquor this draft loss is remarkably constant and affected only by the quantity of gas flowing. Because of the slow speed at which the evaporator wheels are rotated the power input to a machine of the type is small. A large evaporator, capable of producing liquor having a solids concentration of 65 to 70% solids, and having capacity to serve a 350-ton recovery unit will normally require only 50 hp.

In recent years several important improvements have been made in the design of these evaporators. One such improvement was the introduction of tubular evaporating surface in place of the flat plates that had been used previously. Due to the favorable arrangement factor of the tubular surface the evaporating rate per unit of area was considerably increased thereby permitting a marked reduction in evaporator size for a specified duty. This improvement in performance came at a most opportune time since the larger recovery units were beginning to require evaporator capacity which would have been difficult to obtain from evaporators using a plate-type surface. The use of tubes in the evaporator wheels had a secondary result of providing a much stronger wheel structure. At about this time welded end plates and heavy cast steel hub spiders were also introduced, these changes all contributing to greater reliability and lower maintenance.

Black liquor leaving the direct contact evaporator will contain a certain amount of lumps. Some of these

lumps are formed by dried liquor which collects on the sides of the evaporator body just above the liquor level, and some are formed by carryover ash which is dislodged from the boiler and economizer surfaces when the soot-blowers are operated. Because of this it is desirable to screen the liquor between the evaporator and the salt cake mixing tank.

Figure 9 shows a new type of flow box and screen which has been designed for this specific application. It consists of a drum-type screen, vertically mounted with the liquor flowing from the outside of the screen toward the center and then downward through a connection to the salt cake mixing tank. This screen is driven by a small fractional horsepower motor-reducer at about 6 r.p.m. A spring-loaded scraper bar bears against this screen to remove any lumps which are caught by the screen. This scraper bar is hollow and piped up to a steam supply. Holes are provided in the face of the bar which is in contact with the screen so that any tendency for the liquor to plug the holes in the screen is minimized by steam being discharged through the holes in the scraper bar. The lumps that are removed by the scraper drop into the lower part of the screen box and are kept continually agitated and dissolved by steam introduced by a small perforated pipe extended down from the bottom of the scraper bar. As these lumps are dissolved they become part of the black liquor in the screen box and thereby flow through the screen and back into the liquor system.

The screen is completely housed and the small amount of vapor coming from the hot liquor at this point can be conveniently vented to the boiler outlet gas duct. A further advantage of this design over those previously used is that both the upstream and downstream face of the screen can be viewed by the operator. This is possible since the screen is open at the top except for the spokes of the spider which attach it to the central shaft. With this arrangement should the screen begin to plug, this condition can be anticipated by checking the liquor levels on either side of the screen, thereby permitting the operator to take appropriate action before the liquor flow is interrupted. Also the screen is easier to maintain since the slow rotary motion eliminates the mechanical problems which were inherent with the oscillating motion employed in the earlier designs.

The concentrated black liquor is introduced into the furnace by means of liquor spray guns mounted on opposite sides of the furnace. In order to secure uniform distribution of liquor across the furnace and to make the fullest possible use of the furnace cavity for drying, the guns are mounted on a rocker shaft which imparts an oscillating motion to the sprays. This mechanism is so arranged that the spray guns rock up and down in a vertical plane through an angle of about 45°. In order to obtain angular positioning of this movement the connecting rod driving the rocker shaft has been made so that its length is adjustable. A hand wheel is provided for easy adjustment; by shortening the rod the sprays are raised and by lengthening the rod the sprays are lowered. This feature allows the sprays to be positioned for best over-all furnace operation.

Figure 10 shows the assembly of the spray guns. These guns are designed to operate on low liquor pressures, the usual operating pressure being about 25 p.s.i.g.

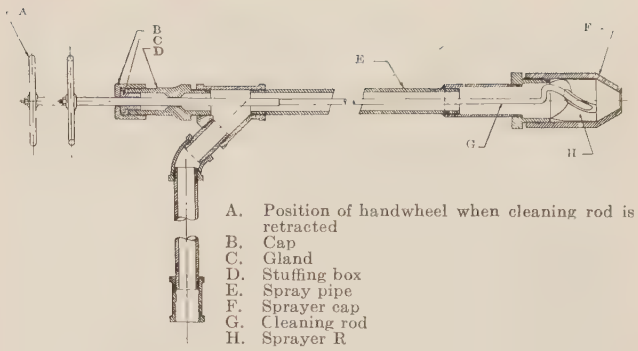


Fig. 10. Black liquor spray gun

The use of low pressure permits large sized liquor passages in the sprayer plates thereby minimizing the possibility of these openings becoming plugged. The spray guns are equipped with an internal cleaning rod which permits the spray openings to be cleaned should any lumps become lodged in the sprayer plates. Either two, four, or six, of the spray guns are used, the number installed being dependent on the size of the recovery unit. Since each nozzle has two passages in its spray plate the plugging of one passage does not seriously reduce the amount of liquor being fired, especially in the larger units where four or six guns are used.

In order to secure the effect of flash drying in the furnace, the black liquor is heated to a temperature slightly above its atmospheric boiling point. This heating is done in two stages. The first stage of heating is done immediately after the liquor has left the salt cake mixing tank and before it enters the black liquor pumps. In this stage the temperature of the liquor is increased to about 210°F. thereby reducing its viscosity so it can be easily handled through a centrifugal pump. After the pump the liquor is passed through a second heater which heats the liquor to its final temperature.

Direct-type steam heaters have proved to be the most desirable heaters for this purpose. Their operating advantage is that they do not foul up, and therefore it is not necessary to have duplicate heaters with the attendant complicated piping systems required for changing heaters while the dirty heaters are cleaned. Also this type of heating permits extremely close control of black liquor temperature since a change in steam pressure to the heaters gives an almost immediate response in the liquor temperature.

As previously stated the black liquor is heated above its atmospheric boiling point just prior to injection into the furnace. This temperature is usually 235 or 240°F., however, the exact temperature is dependent on the solids concentration and the viscosity of the liquor being fired. As the heated liquor leaves the spray nozzle there is a partial flashing of its water content. This has the action of expanding the initial particle to many times its original size, thereby increasing the surface from which the residual moisture can be evaporated. As the black liquor falls to the bottom of the furnace cavity it travels countercurrent to an ascending stream of hot gases which have been formed by the combustion of black liquor solids previously deposited on the hearth. As a result the remaining moisture in the black liquor is immediately evaporated and the dry, porous, black liquor particle falls upon the burning fuel bed.

Because of the uniform dryness and extreme porosity of the particles, an ideal condition exists for the burning of the combustible and the smelting of the ash. The porous fuel bed permits good penetration by the primary air thereby promoting a smelting condition within the fuel bed which results in a high percentage of the sodium sulphate (Na_2SO_4) in the ash being converted to sodium sulphide (Na_2S).

By adjusting the final liquor temperature a considerable amount of control can be exerted on the size of the final liquor particle and the amount of flash drying obtained. This permits the operator to adjust conditions so that stable combustion can be maintained and the carryover of black liquor particles held to a minimum.

SUMMARY

A review of recent recovery unit installations indicates that there has been no basic changes made in the design of this equipment since the vertical tower type unit was first developed during the period between 1937 and 1940. However within the past 10 yr. there have been many improvements made on this basic design. These improvements have resulted in a reduction of the operating labor and maintenance chargeable to the recovery unit per ton of pulp production.

One of the most recent developments has been the introduction of an improved superheater design. In this design the superheater tubes making up each element are arranged tangent to each other so as to form platens, these platen elements being placed on much wider spacing than had been used previously. This new arrangement has resulted in a superheater which is less susceptible to slag accumulations and which permits easier removal of slag formations by standard soot blowers. Operating experience with this type of superheater surface has indicated that the necessity for hand lancing in this section has been completely eliminated.

Recovery unit capacities have been steadily increasing and at the present time specifications calling for units of 350 to 400 tons capacity are not uncommon. In order to obtain more satisfactory heat and power balances mill designers have been requesting higher steam pressures and temperatures. Generally speaking their requests have been satisfied and at the present time there are several recovery units installed and operating with steam conditions of 850 p.s.i. and 825°F.

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Reduction of Chemically Modified Cellulose by Sodium Borohydride

ALEXANDER MELLER

It was shown recently that the low "hot alkali stability" of acid degraded celluloses (hydrocelluloses) increased considerably by oxidation with chlorous acid (*1*). The "hot alkali stability" was expressed in terms of per cent loss in weight measured on heating celluloses with 1% sodium hydroxide solution for $2^1/_2$ hr. at 100°C.; the lower the loss in weight the lower is the "hot alkali stability." Since chlorous acid is regarded as a specific reagent for the oxidation of aldoses to aldonic acids (*2*), the chlorous acid oxidized hydrocelluloses would contain gluconic acid anhydride units. This type of oxycellulose was designated as "glyconic acid oxycellulose" (*1*).

The increased "hot alkali stability" resulting from chlorous acid oxidation of hydrocelluloses provided evidence to show that the hot alkali sensitivity of acid degraded celluloses is predominantly influenced by carbonyl groups (hemiacetal end groups) present. This conclusion was further supported by results obtained on investigating the "hot alkali stability," and carboxyl and carbonyl contents of methanolized hydrocelluloses, and dichromate and chlorous acid reoxidized dichromate oxycelluloses (*1*).

Sodium borohydride has recently been applied for reducing various sugars, aldonic lactones, alduronic esters, and polysaccharides (*3*).

It was anticipated that by reducing the terminal aldehyde (hemiacetal) group of the end units of acid degraded cellulose to an alcoholic group its hot alkali sensitivity will decrease.

The results of preliminary experiments listed below have fulfilled these expectations.

Cellulose sample	*"Hot alkali stability"*
Cotton fibers	2.8
Hydrocellulose "W"	43.0
Alkaline reduced hydrocellulose "W" (cellulitol "A")	6.9
Hydrocellulose "D"	42.8
Alkaline reduced hydrocellulose "D" (cellulitol "B")	18.1
Chlorous acid reoxidized cellulitol "B"	10.6

Reduction of the hydrocellulose samples with sodium borohydride solution at pH 8 decreased considerably their hot alkali sensitivity. While in one reduction a dried hydrocellulose sample was applied ("D"), a second reduction was done by using a freshly prepared hydrocellulose sample ("W") which had not been dried prior to reduction.

It seems that the reduction of the "wet" sample was more extensive than of the dried sample. It is well known that heterogeneous reactions of cellulose with aqueous solutions proceed much slower when dried cellulosic samples are used. The less extensive reduction of the dried hydrocellulose sample is shown by the result

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obtained with the chlorous acid reoxidized cellulitol "B" sample. Its "hot alkali stability" is higher, indicating that the cellulitol "B" sample contained some residual hemiacetal (aldehyde) end groups which on oxidation by chlorous acid contributed to a higher alkali resistance.

It was also anticipated that a reduction of the aldonic acid groups (or lactone) present in gluconic acid oxycelluloses may either proceed as far as the aldehydic or the alcoholic stage. While the former would result in an increased hot alkali sensitivity, the latter would have the opposite effect. The reduction of esterified (methanolized) gluconic acid oxycelluloses would probably take place more readily and would lead to modified celluloses containing aldehydic end units by a reduction in acid solution, and alcoholic units (glucitol) by a reduction in alkaline solution.

The results listed below show that, at least, in a qualitative sense the expectations have been fulfilled.

Cellulose sample	*"Hot alkali stability"*
Hydrocellulose "W"	43.0
Gluconic acid oxycellulose "I"	16.5
Alkaline reduced gluconic acid oxycellulose "I"	9.9
Acid reduced gluconic acid oxycellulose "I"	17.9
Hydrocellulose "D"	42.8
Gluconic acid oxycellulose "II"	17.5
Methanolized gluconic acid oxycellulose "II"	9.4
Acid reduced methanolized gluconic acid oxycellulose "II"	12.9

While the changes brought about by reducing gluconic acid and esterified gluconic acid oxycelluloses are not great, the results are in accordance with the anticipations.

The gluconic acid oxycelluloses seem to contain some residual terminal hemiacetal groups due to incomplete oxidation by chlorous acid. Thus a reduction of these groups to alcohols would increase the "hot alkali stability" but due to a counteraction of aldehyde groups possibly produced by the reduction of the aldonic carboxyl groups to aldehydes the changes are comparatively low. That the gluconic acid oxycellulose sample ("II") may have contained residual hemiacetal groups is borne out by the results provided, e.g., the hot alkali sensitivity of the methanolized gluconic acid oxycellulose sample is lower than that of the parent gluconic acid oxycellulose sample. This stabilizing effect of the glucosidic methoxyl groups present is in accordance with previous observations (*4, 1*).

More completely oxidized and more extensively reduced modified celluloses are being investigated and the results together with the details of the experiments briefly reported here will be published in due course.

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The Use of Sulphur in Kraft Pulp Mills

JOHN E. VASSIE

Improvement in the recovery of sulphur has not kept pace with the recovery of soda. In an effort to more economically utilize elemental sulphur, the use of liquid sulphur has been investigated. The addition of sulphur in the liquid state to kraft pulp mill recovery furnaces has been found to have several advantages over conventional methods of addition. Liquid addition permits better utilization of the sulphur in the furnace in that it can conveniently be added on a semicontinuous basis. This is not the case when manually handling lump sulphur. It has been found that sulphur consumption can be reduced by this more efficient method of handling.

PROBABLY everyone knows why it is necessary to use sulphur in the kraft process. This discussion will therefore deal primarily with methods of using sulphur.

As the industry has progressed recovery methods and practices have become more efficient. The increased efficiency in the recovery of sulphur has not kept pace with the increased efficiency in the recovery of soda. As the salt cake required to make up for soda losses has decreased, it has become necessary to add more and more sulphur to maintain the desired per cent sulphidity. This increased need for sulphur, together with the fact that sulphur is in short supply, has made the economical use of sulphur more important.

Through the years sulphur has been added to the recovery furnace in nearly every conceivable way and to some points outside the furnace. It is still rather general practice to shovel the lump sulphur into the door of the furnace. Because of the design of modern recovery furnaces, manual addition of sulphur is not only cumbersome, but furnace operation is directly affected. We have found that by melting the sulphur and pumping it into the furnace, it has been possible to obtain better efficiency from the sulphur, to save labor, and to get better furnace operation.

Sulphur has some unique physical properties which should be reviewed before going further. It has a specific gravity of 1.808 in the fluid state at 239°F. and a specific gravity of 2.07 in the solid state. It melts at 235°F. and becomes increasingly more fluid as the temperature increases up to about 300°F. It then becomes more viscous until in the neighborhood of 320°F. it is quite viscous. As the temperature is increased further it becomes increasingly viscous until about 400°F. where it tends to become more fluid, boiling at 831°F. This wide range in the viscosity of liquid sulphur with

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variations in temperature must be considered in pumping and metering. While sulphur has been handled in a liquid state for many years in the sulphuric acid industry, the small flow rate needed for continuous addition in pulp mill recovery systems presents added problems. While, naturally, sulphur requirements vary considerably from mill to mill, the range of usage would probably be between 0.1 and 1 g.p.m. It is easy to see that the small clearances in valves and metering equipment for these small flows can present quite a problem.

In the first attempt to pump liquid sulphur to the recovery furnace a steam-jacketed melting pot and steam-jacketed pipe lines were used as presently practiced, but with standard gate valves and a homemade, steam-jacketed, gear-type pump. The clearances in this type pump were too small and, while it would work successfully for a short time the gears would soon freeze. Also, sulphur would work into the packing gland and harden, causing a shutdown. For the same reason standard gate valves were not successful as sulphur would work up around the stem and freeze the valve. The jacketed melting pot was fitted with a screen over the pump suction and with a drain to permit periodic cleaning of sludge. Steam jacketed indicating rotometers, calibrated for flow from 0 to 800 lb. of sulphur per hr., were also installed. These were never successful as the slightest amount of foreign matter would plug the small openings of the valves and rotometer passages.

The sulphur melting tank is a steam-jacketed, conical, bottom iron tank, 5 ft. in diameter by $3^1/_2$ ft. high on the straight side. The conical bottom is fitted with a large pipe flange and blank for easy clean-out. The pump suction is near the bottom of the straight side. A piece of screen plate with 0.075-in. perforations, approximately 6 sq. ft. in area, is built into one side of the tank to cover the pump suction connection. All sulphur is thus screened through this screen plate. This tank has given good service with no evidence of corrosion after 3 years of service. There is a small amount of erosion caused by floating debris. Another of the company's mills is using a plain tank with steam coils on the bottom and around the inside. This has proved quite satisfactory for melting the sulphur, but there has been considerable trouble with the coils. Apparently, steam leaks developing in the coils have caused corrosion. The present tank is being replaced with one equipped with surface coils on the outside. In the author's opinion, this is probably the best system for a new installation.

From the melting pot the liquid sulphur is pumped through $^1/_2$-in. stream-jacketed pipe to the rear of the recovery furnaces. An individual drop line from the header delivers sulphur to each furnace. The line is jacketed up to the point that it enters a hole in the primary air duct, and a delivery nozzle extends to the inside edge of the furnace wall. The steam-jacketed pipe was made from regular 1-in. pipe welded over $^1/_2$-in. pipe. It was not practical to jacket the elbows, tees, and unions and some trouble has been experienced with these portions. Another of the company's mills installed prefabricated steam-jacketed pipe and fittings and has had no trouble. This installation consists of $1^1/_4$-in. pipe inside of a 2-in. pipe.

A pump which has proved very satisfactory is a 1-in. steam-jacketed centrifugal. Standard $^1/_2$-in. steam-jacketed plug valves, which are fitted with a hollow plug for using stick-type lubricant, are installed at all necessary control points. These valves give good service, but they will freeze if not kept well lubricated.

The liquid sulphur is pumped to the furnaces in a semicontinuous manner by the use of a timer switch on the pump motor. This timer is so designed that the pump is started every 5 min. and runs for any predetermined length of time between 0 and 5 min.; thus the sulphur is introduced to the furnace in small shots every 5 min. The amount of sulphur delivered to the furnaces is controlled by setting a proportioning dial on the timer which controls the length of each pumping. This setting can be calibrated for any given pump and line setup. It has been found that one pump and timer setup is adequate to handle two furnaces. If more than two furnaces are involved it would probably be desirable to have two or more pumps and timer switches. A recording thermometer with the bulb in the liquid sulphur as close to the pump suction as possible is very desirable. If a recording thermometer is not used, an indicating thermometer should be used in the same manner. A recording liquid level gage mounted on the tank on the suction side of the screen gives a continuous record of pump operation, sulphur consumption, and sulphur additions to the tank.

There are several points that should be emphasized in setting up a liquid sulphur system. All reasonable care should be exercised to keep dirt and other foreign matter out of the sulphur. Otherwise, this foreign matter will soon plug the screen and fill up the bottom of the tank causing frequent shutdowns for cleaning. Temperature of the liquid sulphur should be controlled as closely as possible between 290 and 310°F. since this is the temperature range in which the viscosity of sulphur is both the lowest and undergoes the least changes. If this range is too narrow, variations should be to the lower rather than the higher side. High temperatures are to be avoided. Saturated 60-lb. steam has been used very successfully for this purpose. Close attention should be given to steam traps, particularly in the steam-jacketed lines, to see that they are working properly and are so located as to remove all the condensate.

There are several distinct advantages in the use of liquid sulphur over the use of lump sulphur which more than offset the initial extra equipment expense. While maintaining the same per cent sulphidity substantial savings in sulphur consumption can be realized. This is easy to understand when it is considered that a large part of the lump sulphur shoveled on top of the furnace bed can be expected to be lost with the furnace gases, while the great majority of liquid sulphur supplied in small quantities is utilized. It is estimated that the use of liquid sulphur has resulted in labor savings equivalent to half a man or 12 man-hours per day. In addition to these benefits it is not necessary to open the furnace door for the purpose of shoveling in sulphur. This, of course, results in better steam production, more uniform furnace operation, and in some cases when the furnace is operating just on edge, the elimination of the black-out of air ports in the vicinity of the door.

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Numerical Evaluation of Printability of Paperboard

CLYDE ECKHART and L. K. BURNETT

Parts of two published methods for determining printability of paper and paperboard have been combined to secure a numerical evaluation of paperboard printability. Unknown paperboard samples are compared to a standard sample by simultaneous printing from a graduated halftone electrotype. Ink coverage is determined by brightness measurements. Fidelity of image reproduction is measured by visual comparison to ideal printing standards. Combination of these values yields a numerical evaluation of printability. By this method, the mill learns of variations within a run and from run to run, while the carton printer learns what to expect from each run of board. Results show only limited correlation with physical tests.

THE production of paperboard of uniform characteristics within a given mill run and from one mill run to another is a problem in many paperboard mills. A large quantity of the paperboard produced today is converted into printed cartons. One of the main problems of a paperboard mill making such grades is to make board which will print uniformly well throughout a mill run and from run to run. The carton printer also has a problem in printing board of unknown printability.

The evaluation and control of the printability of paperboard are not well understood. Several routine control tests have been established to furnish a guide to better printability, but correlation between these physical tests and actual printing results is not too good. Something better than these physical tests seems desirable to predict the behavior of paperboard in the printing operation. The following is a description of a method used in determining the printability of paperboard made and used by a large integrated mill and carton plant. The method is a combination of the methods described by International Printing Ink (*1*, *2*) and R. A. Diehm (*3*).

DESCRIPTION OF METHOD

Since the closest approach to actual production printing is proof press printing, a no. 219 Vandercook press is used in this method. This press is similar to the no. 4 Vandercook press: the main difference lies in its larger bed and cylinder which made it more adaptable to proofing of paperboard. The cylinder is undercut 0.040 in. and when this is packed to 0.045 in. with tympan and the paperboard to be printed, printing impression of 0.005 in. is obtained. A specially treated 65-line halftone screen electrotype 4 by 8 in. consisting of six graduated tones from about 12 to 87% in 1-in. bands and a solid portion 2 in. wide is mounted on the patent base. The screenwork in the electrotype is pre-madeready by treatment with the Bishop-Stensel process. Essentially, this means that the 87% tone area is recessed approximately 0.001 in. below the solid area. Likewise, the next lower tone is recessed approximately 0.001 in. below the 87% tone. This continues down the line so that the lowest tone (12%) is 0.006 in. under the solid area. A standard halftone black is employed throughout the printing procedure.

Since the object of this test is to evaluate the printability of paperboard throughout a mill run and compare it with results of subsequent runs, samples 12 by 12 in. are collected every 2 hours from the middle of each paperboard mill on all production orders of carton board. All samples are conditioned 24 hr. in a room at 50% relative humidity, 73°F. temperature. A 1 by 12-in. strip is cut in the cross-grain direction for each sample for printability evaluation, and the remainder of the sample retained for further testing.

Three such 1-in. strips are placed next to each other along with a similar strip of standard board. A standard board of known printability is tested with each set of printability samples in order to provide a reference point. Standards are set up for each of the major grades of board, i.e., patent coated, clay coated, bleached Manila, and for ranges of approximately 8 points (0.0008) within each grade. All four strips are made the same thickness by underlaying them with paper shims which compensate for caliper variations. The strips (and shims) are then stapled to an ordinary sheet of paper of appropriate size to give them stability, at which time they are ready to be printed.

Two and one-half cubic centimeters of standard halftone black ink are placed on the solid vibrator of the Vandercook press with a volumeter and allowed to distribute. The rollers are set as lightly as conditions permit. The halftone plate is inked once, and five proofs on smooth clay-coated paper are printed and discarded. A set of test strips is now printed under the standard 0.005-inch impression, and the cylinder is turned over at a normal rate (Fig. 1). Another clay-coated proof is pulled and discarded, and the next set of samples is printed. If the clay-coated proof shows a need for ink to be added, an additional 0.25 cc. of ink from a volumeter may be evently applied to the vibrator with an ink spatula. An evaluation of several test specimens of standard board will show what film thickness tolerance is allowable before the printability is affected (Fig. 2).

EVALUATION

The first step in the evaluation of results obtained by this test method is to determine the ink coverage (I.C.) of each strip. This is done by measuring the brightness of the 12% or lightest tone and subtracting from it the brightness of the 87% tone. This difference is then divided by the brightness of the paperboard, and the result is a quantity called the ink coverage. The term brightness as used here is measured by means of

CLYDE ECKHART, Ink Technician, and L. K. BURNETT, Manager of Production Control, Ohio Boxboard Co., Rittman, Ohio.

the General Electric Reflection Meter, or with suitable calibration, by other instruments (Figs. 3 and 4).

$$\text{I.C.} = \frac{\text{B12} - \text{B87}}{\text{BP}} \times 100$$

The next step is the evaluation of the fidelity of reproduction of the plate image on the paperboard by the

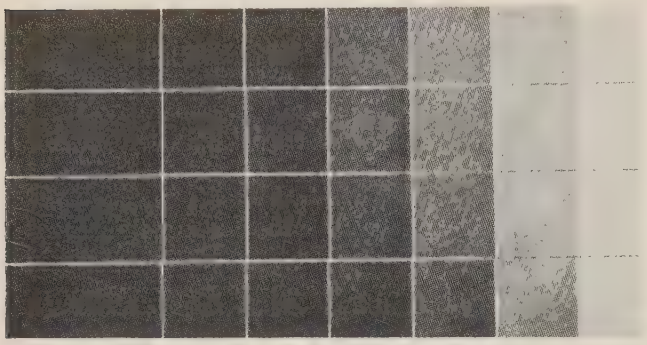

Fig. 1. Mounted printed samples

ink. Each tone is observed with a magnifying glass of some sort (10× or more) and given a value according to three specific rules: (1) first, if all dots are present, a value of 2 is assigned; if up to one fourth are missing, a value of 1 is given; and if more than one fourth of the dots are missing, the tone receives zero. (2) Second, if all dots are unbroken and unconnected, tone is assigned a value of 2; if up to one fourth are broken or connected, a value of 1 is given; and if more than one fourth are broken or connected, tone receives a value of zero. (3) Third, if each dot is uniform and perfectly like every other dot, a value of 2 is assigned;

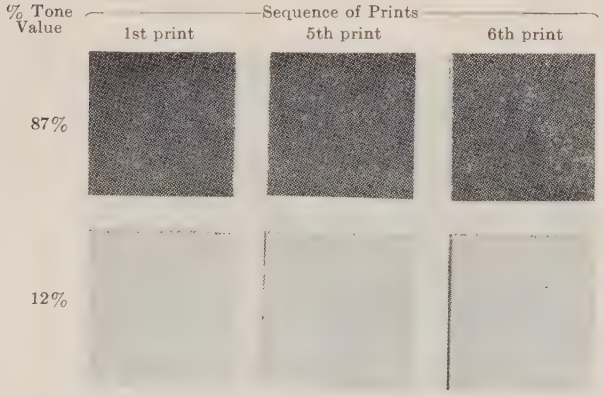

Fig. 2. Effect of variation of ink film thickness

if up to one fourth are nonuniform, a value of 1 is given; and if more than one fourth are nonuniform, tone receives value of zero. Thus, it is possible to obtain a value of 6 for a perfectly reproduced tone, and since there are six tones, a value of 36 points is obtainable for a given strip. This value is called the print fidelity (P.F.) or the ability of a piece of paperboard to exactly reproduce a given tone value or values.

The final step in the evaluation of printability is the combination of the aforementioned results expressed in terms of perfect printability. The result is a term called printing quality (P.Q.), *which is defined as the print fidelity at perfect ink coverage.*

$$\text{P.Q.} = \frac{\text{I.C.} \times \text{P.F.}}{k}$$

where k = constant of perfect printability. The constant k is the product of perfect ink coverage, which is the difference between the lightest and deepest tones (0.75) and perfect print fidelity (36). In this method $k = 27$ (Fig. 5).

It has been found that an evaluation of a given board,

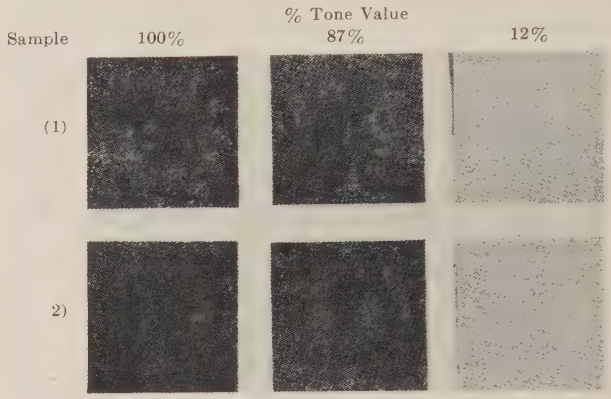

Fig. 3. Extremes in ink coverage

considering a given film thickness tolerance, instrumental precision, and other experimental variables, will be reproducible to within ±3%.

APPLICATION

This method of evaluating printability of paperboard does not lend itself to routine mill control of printability during a given mill run because of the time required to make the tests but it does yield information which is valuable to both mill and carton plant.

It provides the mill with information as to the comparison of the printability of the current run with print-

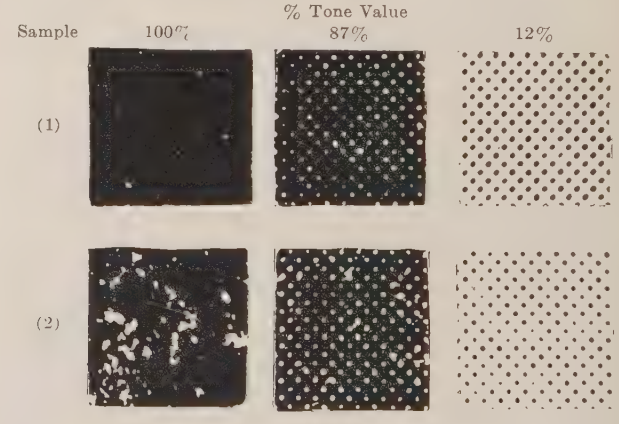

Fig. 4. Extremes in ink coverage

ability of a standard sample and with previous runs (Fig. 6). It also shows up variations during the run so that they can be correlated, where possible, with production experience and physical test results.

It provides the carton plant with a preview of the board before they start to use it. It furnishes them with information about variations in printability during a run which may not have been detected by routine mill physical tests. If portions of the mill run require more or less ink to produce satisfactory printing quality, such board can be run together with the proper ink adjustment.

The method also makes it possible to get a comparison of printability of two lots of similar board with minor furnish or surface treatment changes.

We believe that the most important application of the method is in providing a numerical rating of printability

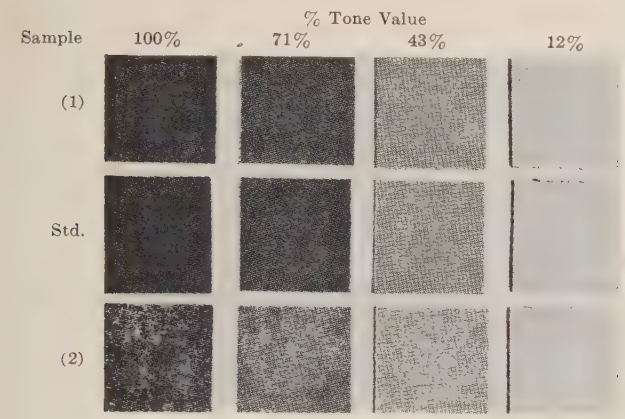

Fig. 5. Extremes in printing quality

so that the mill has an evaluation of the printability of the board made during each run shortly after the run is completed. By following these evaluations carefully, we hope to find the variables in the mill operation which cause good and poor printability and attempt to control them so that the mill product will have uniformly good printability.

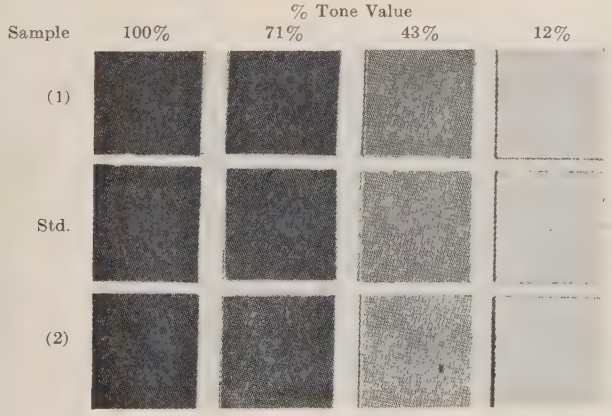

Fig. 6. Variation in printing quality from run to run

We believe that the method could also be used to compare the printing quality of different inks on the same paperboard but have not yet applied it to that use.

CORRELATION WITH PHYSICAL TESTS

Since this printing quality evaluation does not lend itself readily to routine mill control of carton board, it would be desirable to find tests which will give direct correlation with printability results. To date, we have not found any single physical test or any group of physical tests which correlate with printability as determined by this test. Preliminary tests on a number of samples seem to indicate that, in general,

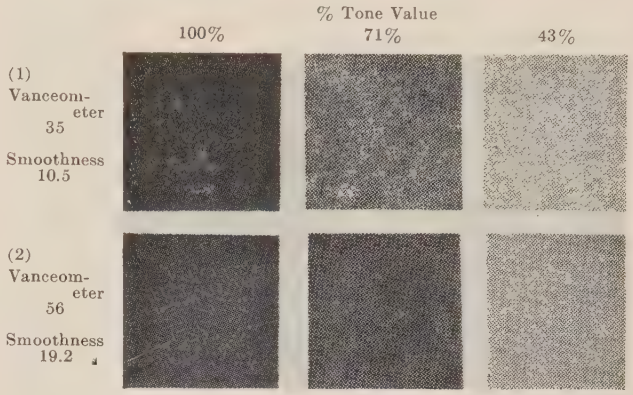

Fig. 7. Variation in printing quality related to physical tests

printability improves with increased ink resistance as measured by the Vanceometer and with improved smoothness as measured by the Bekk smoothness tester (Fig. 7). However, these tests only cover a limited range of ink resistance and smoothness. Undoubtedly, above a certain value, printability would cease to improve. Our observations still show many cases of good and poor printability which cannot be explained by physical tests.

CONCLUSION

A method is described for determining a numerical evaluation for the printing quality of paperboard. Samples of the unknown board are printed in comparison with a standard sample on a proof press. The proofs are then evaluated for ink coverage by brightness measurements on the printed and unprinted parts of the board and for fidelity by visual comparison with ideal standards. From these two values, a numerical evaluation of printing quality is calculated. Limited use of the method in a large integrated board mill-carton plant operation indicates that it differentiates between board of good and poor printability and provides information that is useful to the carton department in using the board and to the mill in improving succeeding runs. Only limited correlation with physical tests has been observed.

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Converting to High Capacity Pulp Screens

W. C. STEVENS, A. P. LYNCH, and P. W. ESTES

The experience of one mill is described in converting from small capacity screens to Cowan centrifugal pulp screens in both groundwood and sulphite mills. The value of screen plate coating is indicated and maintenance problems are described.

IN THE pulp and paper industry much has been accomplished in recent years to increase the capacity and operation of process equipment to meet the heavy demand for paper in its various forms. Paper machines have been speeded up and pulp mills have been forced to satisfy increasing demands. Seldom has this been done by adding slightly to existing equipment in pulp mills. In most instances, the problem was to supply more pulp of better quality at a cheaper price. To accomplish this it was often required to design new equipment to fit into existing facilities. One of these comparatively new developments has been the Cowan centrifugal screen. Its operation on sulphite and groundwood pulp over a 5-yr. period is the purpose of this paper.

The Cowan centrifugal screen is the result of development work begun over 15 years ago. The design is based on three assumptions:

1. When a mixture of pulp and water is rotated, the fibers tend to align themselves in the direction of flow.
2. By means of a rational analysis, a screen may be designed so that the fluid suspension will be uniformly distributed over the screening area with a minimum hydraulic loss.
3. Power required for work of screening is the energy needed to bring water from rest to the peripheral speed of the rotating element.

DESCRIPTION OF COWAN SCREEN

The Cowan screen is essentially two screens in one. It is constructed usually of cast-iron end frames and base with a fixed mild steel top cover. The end frames are made interchangeable so that with the same hand impeller the discharge may be made either right or left hand. Two aluminum, or stainless steel, doors are sealed with rubber gaskets and are held in place by screw clamps. The three plate frames, with eyebolts for easy removal, are supported on rings that are part of the end frame castings. These rings are grooved for a circular rubber gasket on which the plate frames rest. The screen plates are fastened to the frames with concealed screws.

The impeller and shaft construction are such as to give what is tantamount to two screening operations in one piece of equipment. The shaft is constructed of seamless tube and turned steel and carried by self-aligning antifriction bearings. The impeller, of approximately 42 in. diameter, is constructed so that the blades project from a barrel 16 in. diameter and 18 in. long on the inlet end and from the hub on the balance of the impeller. The stock mixture enters the screen through a 14-in. cast-iron elbow and flows out radially from the impeller barrel through horizontal slots between the blades about $1^3/_4$ in. wide and 17 in. long. The accepted stock is forced through the screen plates under the action of centrifugal force. The unscreened stock is carried axially by the impeller blades toward a circular baffle situated at the end of the barrel. As the mixture passes around the baffle, the thickening pulp suspension is diluted by white, or fresh, water supplied through the hollow shaft to $^5/_8$-in. holes extending through the shaft and impeller hub between the blades. Water pressure required is 5 to 10 p.s.i. At the discharge end of the impeller another circular baffle acts as a dam to insure good washing before rejections are allowed to bleed past the end of impeller blades and discharge from the screen.

The first screening action takes place over 40% of the inlet end of the screen area and the quality of the accepted stock depends upon plate perforations and consistency. The second screening action occurs over the remaining 60% of the screen area and here the quality of the pulp depends upon plate perforations and the amount of wash water introduced through the hollow shaft.

The Cowan screen impeller speed is 240 r.p.m. and it is driven by texropes, or flat belt with idler pulley, from a motor mounted on top of the screen, or floor mounted. Power requirements are 0.5 to 0.75 hp.-days per ton for newsprint grade groundwood and 0.75 to 1.15 hp.-days per ton for sulphite.

COWAN SCREEN ON GROUNDWOOD

In 1948 as part of a renovation project in the groundwood screen room, the first of four Cowan screens was installed. The initial installation proved so successful from an operating point of view that the other three screens were quickly installed. The new screens and accessories occupy only 450 sq. ft. on a neat concrete platform. They replaced an ugly, closely packed, wooden platform crowded with ten small capacity centrifugal screens, motor, spouts, and piping that occupied about 2400 sq. ft. In addition it was possible to eliminate three of five centrifugal secondary screens with a saving in floor space of 350 sq. ft.

The power requirement of the old screens was 1090 hp. while with the present arrangement the demand is only 495 hp. This saving in power amounts to about $24,000 a year.

The first Cowan screen was installed on coarse groundwood pulp made from pine with a grinder pit freeness of about 200. All parts exposed to the stock had been factory phenol-coated including the copper screen plates. Where one old screen labored hard to handle 35 tons per day, the new installation handled 100 tons

W. C. STEVENS, Sulphite Superintendent, A. P. LYNCH, Groundwood Superintendent, and P. W. ESTES, Assistant Chemist, Otis Div., International Paper Co., Chisholm, Me.

per day without difficulty. In the old type screen uncoated copper plates with 0.060-in. perforation had been used. For the new installation phenol-coated copper plates with 0.050-in. perforations after coating were installed. Pulp quality met paper mill requirements and only 6% of the total rejections was fiber that was acceptable for paper mill use. After a few months' satisfactory operation, uncoated copper plates with 0.060-in. perforations as used in the old screens were tried and almost immediately removed as pulp quality fell off.

The installation of Cowan screens on finer groundwood grades was also a decided improvement in screening operation. Here pulp made from spruce and fir, with a grinder pit freeness of about 90, is screened. Phenol-coated copper plates with perforations after coating ranging from 0.035 to 0.050 in. are used and an attempt is made to get the heaviest gage plate possible for the perforations desired. Some of the plates are perforated one size and others in two sizes.

The size of perforations in rotary screen plates is a subject of much discussion. The plant, by trying various combinations, has found plates that screen the pulp satisfactorily for the grades of paper made.

In the operation of the screens an attempt is made to feed with a uniform consistency and hold the tailings to a uniform consistency. The screens are fed at 0.6 to 0.7% consistency. This is higher than that fed to the old screens and the plant benefits by increased deckering capacity with the same number of deckers. The consistency also gives an acceptable grade of pulp over the 40% of screen area nearest the inlet. Since there is an increase in consistency across the screen and a gradual building up of a coarse mat of fibers which assists in the removal of fine dirt, it is necessary to add only the proper amount of shower water through the hollow shaft to screen a desirable pulp over the remaining 60% of the screen area. As the amount of stock fed to the screen varies, so must the shower water. Too little shower leads to plugged screens and excessive shower washes everything through. Screening at too low a consistency also allows undesirable slender slivers to partially pass through the perforations where they remain until broken off.

COWAN SCREEN ON SULPHITE

Following a short trial on groundwood screening, Cowan screens were placed in operation in the sulphite screen room. In the old screening layout there were four small capacity centrifugal primary screens, two secondary screens, and three flat screens with the necessary headboxes, spouts, and pipes crowded into 1925 sq. ft. of floor space and capable of a screening capacity of 100 tons per day. The new installation, with a capacity of 160 tons per day, consists of two Cowan primary screens and a third Cowan as a secondary screen and occupies only 400 sq. ft. In addition, it was also possible to eliminate a white water booster pump and tailings pump for the flat screens.

As in the groundwood mill, the change in power needed to operate the sulphite screen room brought considerable savings. The former layout required 550 hp., while the new installation needs only 250 hp. This saving in power amounts to at least $12,000 a year, and very likely more, as the old layout was always fully loaded and the new one hardly ever. The new installation requires only one operator while two were formerly employed to operate the screen room. Based on 6-day operation this means an additional saving of approximately $10,000 a year.

In all three sulphite screens phenol-coated copper plates with 0.050-in. perforations after coating are used. Stock is fed to the Cowan primary screens at 0.7 to 0.8% consistency after being screened on a vibrating-type knotter with $^3/_{16}$-in. perforations. As the efficiency of the screen in removing dirt is related to the ratio of consistency to size of plate perforations, the manner in which the screens are operated is varied from time to time as the amount of stock to be screened fluctuates according to paper mill requirements and cleanliness of wood supply. Rejections from the primary screens can be varied from practically nothing to 5 to 10% as desired by control of shower water. This mixture is then fed to a Cowan secondary screen where the final amount of rejections is controlled to give an acceptable pulp to be added without further treatment to the accepted stock from the primary screens. The sulphite and groundwood rejections are not lost entirely as they are carried along to be added to a wrapper machine furnish.

MAINTENANCE

All of the screen plates and frames are factory coated as well as all interior surfaces of the screen and the resulting cleanliness is striking when compared to the heavy slime conditions we used to experience. Both phenol and rubber coatings have been tried on the screen and it was found for our mill that the phenol coating is far superior. Rubber coatings have peeled off within a year.

Copper screen plates are phenol coated at the factory and the exact size perforations after coating as ordered are obtained. The value of this coating may be seen from plate life experienced in the sulphite mill. Uncoated plates gave an average life of $4^1/_2$ mo. while coated plates resulted in an average life of 12 mo. In the groundwood mill an average life for all sizes of coated perforated plates is 18 mo. The heaviest gage plate possible for each size perforation is secured because the breaks are pressure breaks. The plate shows no loss in coating and it is possible to patch and return the plate for service for a considerable length of time.

After the value of coated plates had been proved in the pulp mills, they were introduced successfully into the paper mill. Trimby screen, uncoated bronze plates with 0.080-in. perforations were enlarged to 0.085 in. in 2 mo. and failed after 5 mo. service. Phenol-coated plates were tried with 0.072-in. perforations after coating and gave 30 mo. service with no apparent increase in the openings. The screen capacity with coated plates was much greater than with uncoated plates. The same experience has been true of coated Bird screen plates that have been in service over 2 yr. and show no appreciable wear.

Returning to Cowan screen maintenance, difficulty has been experienced with cast-iron inlet frames on the first installations which is not surprising if one knows the Androscoggin River. The ring supporting the plate frames eroded in about 2 yr. making it necessary to replace the whole inlet frame. The replacement was a

Ni-resist casting with phenol coating. After more than 2 yr. service this frame appears to be in the same condition as when installed and the coating does not appear to be worn. It is believed that future screens will have a replaceable ring of a more durable alloy.

We experimented with welded mild steel coated impellers and found that they would give only 1 yr. service in our mill. The present bronze rotors in the groundwood mill and chrome-nickel steel rotors in the sulphite mill give no indication that they need replacement after 4 yr.

There has been a tendency in our installations for the shaft to wear at the end of the bronze sleeve where the shaft passes through the inlet elbow. It is planned that future shafts will carry a CNS sleeve extending into the barrel of the rotor.

CONCLUSION

We believe the Cowan screen has been the solution to many of our problems. It gives a good clean pulp, has great capacity and is, therefore, much more economical to run. The difficulties that we have experienced may be peculiar to our mill and, if they are not, we still regard it as a highly desirable piece of process equipment.

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Experiences in the Abatement of Kraft Mill Odors

Gulf States Paper Corp.

BEN F. MAY

The experiences of Gulf States Paper Corp. with the odor problem since the mid 1920's are presented. A historical presentation is given with the idea that the rest of the industry may gain in knowledge from experiences of this mill. Use of a direct condenser for digester blow gases was the first success toward odor abatement. Chlorine was tried for deodorizing the condenser effluent but was found to be ineffective. Until 1951 all attempts at odor abatement were made with condensers, water spray scrubbers, and improved processing equipment. Trials of odor masking aromatic compounds began in the Fall of 1951. Efforts to effect a milder and less obnoxious odor by use of these compounds have produced a slight trend toward abating odors. However, positive conclusions are pending due to extended trials. Future study involving trial of a scrubber system, employing bleach plant waste liquors, is under consideration. Evaluation of results is the most difficult phase in this field of study. A practical, yet accurate, means of odor measurement is needed. The variables involved are quite complicated, including such major ones as process operating efficiency, meteorological conditions, individuals' nasal characteristics, and mixing of odors from various sources.

This paper is of a historical nature presenting the various methods and efforts toward odor abatement by the Gulf States Paper Corp. This company became odor conscious, so to speak, back in the early 1920's at the Braithwaite, La., mill. The Braithwaite mill produced 50 tons of kraft pulp per day using two rotary-type digesters. Make-up chemicals were salt cake and lime, while black liquor recovery was handled by rotary-type furnaces. Today production capacity is 350 tons per day using eight stationary digesters. The make-up chemicals are still salt cake and lime, while black liquor recovery is handled by two modern type single spray recovery furnaces.

EXPERIENCES AT BRAITHWAITE MILL

By air the nearest residential area of New Orleans was approximately 7 miles from the Braithwaite mill. During the first years of operation of this mill complaints were numerous. This is probably true for any other mill beginning operation in a new locale. From the beginning, management took the attitude of doing anything possible, short of shutting down the mill, toward abating odors. Various industrial chemists were consulted, plus corresponding with other mills, in an effort to find out what latest devices and methods were available for this type problem.

The first attempt made was the installation of a large spray-type direct condenser for the flash steam and gases from the digester blow. It was of simple construction having a weighted flapper-type pressure relief valve on the top for excessive pressure build-ups. The prime selling point for the installation of this condenser was the expectation of using the hot water for pulp washing. At that time everyone noticed that the water had a strong odor but dismissed the possibility of pulp contamination. This was further strengthened by the evidence of no odor from the pulp during the screening, beating, and papermaking operation. It was not until the finished paper was stored in a closed room that the contamination by odor was detectable. It seemed that the odor slowly emanated from the paper and where there was a rapid to medium movement of air the concentration of the odorous compounds did not reach the threshold limit of detection by the human nose. Instead it was only noticeable in a closed room where very little air was moving. Even people using some of the paper for scratch pads noticed the odor when they opened their desk drawers.

However, in less than a month after the condenser was put into operation, complaints from New Orleans dwindled to a point where they were negligible. Even the state health department issued a statement regarding absence of odor. This was the first real success by this company in abating odors, although it was indirect at best. Even so, management was still determined to deodorize the water from the condenser; chiefly for two

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reasons: (1) the odor from the water emanated in the mill area as it flowed through the drainage ditch to a nearby bayou, causing complaints from mill personnel; and (2) it was desired to recover the heat being lost in this condenser water.

After much consultation with several industrial chemists, it was decided to try chlorine for deodorizing the condenser water. Samples were first taken of the outflow water from the condenser tank to which the digester gases are discharged. The chlorine supply line was then connected to the cyclone exhaust line near the exit from the cyclone. This was done in order that the chlorine might have sufficient time to mix and act with the fumes before they struck the condensing water. On the next discharge after connections were made the valve on the chlorine tank was opened and again samples were taken as above. Upon weighing the cylinder after the blow it was found that 53 lb. of chlorine had been used. Upon examination of the samples a marked difference was noticed between the samples treated with chlorine and that without treatment. The treated samples still carried an appreciable amount of the same nauseating odor of the mercaptans, but due to the reduction of this portion of the odor the turpentine odor was decidedly more pronounced. In other words, it seemed that the more volatile type odors were attacked by the chlorine whereas the turpentine was not. It was concluded that there was no question that the use of chlorine tended to reduce the odor in the digester exhaust gas, but even a large excess did not eliminate the odor and did not render the water suitable for pulp washing. Based on this, the chlorine treatment was discontinued.

Mill personnel continued to complain about the odor from this condenser water and some even said that it caused them to be nauseated. It seemed that the odors came at the first blast of the digester blow before condensing water was able to handle the gases and from the steaming water as it flowed through the open ditch through the plant. It was suggested by a consulting chemist that a sufficiently large pipe be connected to the discharge from the condenser tank and carried to a nearby bayou where it would be discharged under water. It was felt that by doing this the odors would be carried far enough away and so diluted as to relieve Braithwaite of the odor from that source. This was not tried due to moving to a new mill in Tuscaloosa.

EXPERIENCES AT TUSCALOOSA MILL

This mill began operation in the latter part of 1928. The plant itself is located on the banks of the Warrior River approximately 4 air miles from Tuscaloosa's population center. This is the point where the foothills of the Appalachians begin to dwindle out and the Warrior River Valley widens from $^3/_4$ to 5 miles in width.

Initial operation at the new mill began with four digesters of stationary design. Digester gas-off was done continuously, feeding to a cyclone condenser setup. This setup was installed for the purpose of recovering turpentine from the cooks and was made up of two cyclones and an indirect-type condenser. The condenser consisted of two old Scott evaporator effects. Black liquor incineration was handled with two of the latest spray-type recovery furnaces. Effluent gases were scrubbed with a water spray before discharge to the atmosphere. Make-up chemicals were salt cake and lime.

Soon after operation began, a direct-type condenser was installed for handling the flash steam and gases during the digester blow. This was similar to the one used at Braithwaite, only much larger. During normal operation this and other equipment installed for handling gaseous effluents did a fair job of holding odors down to the point where they were not a nuisance to local residents.

In the latter part of 1930 Tuscaloosa was being considered as a site for the construction of a new hospital. Some sources were of the opinion that odors from this mill would be very objectionable and aggravating to patients. Rather than answer these complaints with the simple statement that management was doing all possible toward odor abatement, it was decided to have an outside authority inspect the mill and pass judgment as to whether or not the mill was a nuisance to the community.

An expert from the United States Bureau of Standards made the inspection. He was allowed full run of the mill and to ask questions at will. The subsequent report listed and discussed what was thought to be the most serious points of odor escape.

First was the diffuser exhaust. It was stated that this was the most serious escape of odor but no means was used for controlling it.

Second was the safety valve and vacuum breaker on the flash steam line from the cyclone. Malfunction of these valves allowed the escape of a fair quantity of odorous gases.

Third was the statement that inefficient operation of the recovery furnaces caused a large escape of odorous gases. This referred to what is known now as blackouts in the furnace caused by insufficiently concentrated black liquor.

Another source, but classed as a minor importance, was the flashing of black liquor in the storage tanks.

He stated that, while it appeared that the absolute elimination of malodors from the kraft or sulphate process would require extensive research, it was apparent that by making certain definite improvements in the equipment in operation at the Tuscaloosa mill the volume of escaping odorous gases could be greatly reduced. To sum it up, he felt that the plant as a whole had installed the latest and most up-to-date equipment for handling gaseous effluents, and that by stricter operation and control and certain improvements in the existing equipment that the mill could be classed as a nonnuisance to the community.

The company's technical staff made every effort to remedy any conditions reported as existing by the Bureau of Standards survey. An attempt was made to condense the gases escaping from the diffuser exhaust. A line was carried from a diffuser exhaust to the blow gas condenser described earlier. This system would not work due to back pressure which develops during a digester blow. Lines became clogged with pulp and it was found impossible to blow all the pulp from the digester. Considerable time was spent trying to make the system work but when the pipe connection broke due to too much pressure, the system was considered dangerous and abandoned.

Criticism of the opening of the safety valve and vacuum breaker resulted in the installation of a system to prevent gas escape at these points. The black liquor storage tank referred to was put out of use very soon after the mill inspection.

The recovery plant operating procedures were studied in an effort to find and correct any phase of the operation which might be causing inefficient operation. No major discrepancies were found, but the study gave indications that more efficient operation could be had with stricter operating directives. As a result operating personnel became efficiency conscious. The end effect could never be measured, but management felt that every effort was being made in the plant to prevent the escape of malodorous gases and those which did escape were due to conditions which in the light of existing knowledge then were not under the control of the operation of the mill.

In 1933 all Southern and Pacific Coast kraft mills were investigated by management with regards to odor abatement practices and equipment. As a result it was found that this mill was as free from odor as any of those investigated. This had also been borne out by visitors at this mill from other paper mills who often commented on this feature. In general, it was agreed throughout the industry that it was not yet possible in any mill to eliminate all odors under all atmospheric conditions.

From this investigation it was found that there were four major things which were done in other mills to remove odor as far as possible: first, condense all relief gases from the digester; second, condense all blow-off steam and gases; third, send recovery plant gases up a fairly high stack at temperatures above 200°F.; fourth, keep the mill as clean as possible and have all liquor tanks covered.

The Tuscaloosa mill was then doing all of these. In addition, gases from the evaporators were being carried off by a direct-type jet condenser, while black liquor furnace gases were being scrubbed with water sprays.

During the next few years, by continuing to use the same equipment, this mill gained the reputation of being one of the most odorless mills in the South. Very frequently management received inquiries from other mills seeking information as to methods and equipment which were effective in abating odors.

As a special note, during the first 10 years of the Tuscaloosa mill operation, management was approached by five different individuals who professed to be able to eliminate all pulp mill odors. Consideration of their services never got past the correspondence stage. Management made it a policy to be cautious with such propositions as were offered by these sure-cure experts. The first thing they were asked was for references which would give concrete information as to the effectiveness of the methods they employed. In no instance were replies from references conclusive enough to warrant consideration of the proposals presented to management.

The first change made in gas effluent equipment was in 1936. The turpentine condenser began leaking around the tube and sheet connections. An old tube and sheet-type liquor heater was then installed for handling the turpentine gas-off. The condenser was so installed such that the condensed steam and turpentine were drained off through a leg to a decanting tank which acted as a seal for the condenser. This condenser setup worked very effectively and was used until 1948.

From 1939 until 1946, the odor problem at this mill was somewhat pushed into the background. The only change of note in the process during the war period was the chemical make-up. Synthetic salt cake, sodium carbonate and sulphur, was substituted for salt cake. Apparently this caused no great change in the odor problem because complaints from local residents did not increase.

POSTWAR CHANGES AND CONDITIONS TODAY

Immediately following the war this company embarked on an expansion program. Production capacity was increased from 200 to 350 tons per day. The digester section was re-worked and now it consists of eight vertical stationary-type digesters. Digester gas-off is still continuous but is fed to a new turpentine condenser. The gases first go through a cyclone for separation of entrained liquor and pulp. The turpentine vapors and flash steam are then carried to a direct-type condenser. This condenser is made up of trays with the condensing water feeding in at the top and gases coming in at the bottom. The top is open to the atmosphere for safety against pressure build-ups. Condensed turpentine and water feed to a standard decanting tank.

Digester blow gases are now handled by two indirect accumulator-type heat recovery systems. Each of these systems handles a set of four digesters. The heat given up in condensation of the flash steam and gases from the digester blow is used in heating water for pulp washing. One of the systems is a single-cycle, indirect tube and sheet condenser with all condensate going to the ditch directly. The other is a two-cycle, direct and indirect accumulator. Incoming gases are condensed by previously condensed and cooled condensate. Heat removal from this water is facilitated by a vacuum tube and sheet heat exchanger. Overflow from this system goes to the ditch.

Black liquor recovery is handled by two sets of quintuple effect, tube and sheet evaporators with direct jet barometric leg condensers for pulling a vacuum on first liquor effect. Effluent from these condensers goes directly to the ditch. Black liquor incineration is handled by two single spray-type recovery furnaces. Stack gases pass through cascade-type direct evaporators and thence through Cottrell precipitators for recovery of dust. The above-described equipment is still in use.

During the period of expansion previous to the installation of the new turpentine condenser, the old one became very bothersome to operate. The old one was satisfactory in every respect except for capacity. With the increase in digester capacity a greater load was put on the condenser. During this period it was a common occurrence for the condenser to become stopped up with pulp and generally give poor operation. Evidently this allowed the escape of quite a bit of turpentine and non-condensable gases, because quite an improvement was noticed in local odor conditions soon after the installation of the direct-type turpentine condenser.

Based on the general reaction and sentiments of local residents, management feels that present equipment is

the most effective that has been used by this company to date. Rarely do we have complaints from local residents. The majority of complaints come from temporary residents in this area or tourists who are passing through. For instance, there are located two colleges, four hospitals, and various industrial plants all of which bring new people into the local area each year. It is chiefly from these people that complaints originate. Although odors are kept below the point of being a nuisance, management has continued to search for better methods or devices for eliminating odor more effectively.

In September, 1951, this mill was the first to start on a completely new approach to the odor problem. This approach involves the use of aromatic compounds which are introduced in the process at various points. The idea is to mask the pulp mill odor with a more pleasant odor. In some quarters this is referred to as "odor masking."

For the first trial four different mixtures of aromatics were tried under the direction of the manufacturers technical service representatives. Additions were made at three points: namely (1) the digesters at the time of loading, (2) to the black liquor on the way to storage, and (3) into the recovery plant stacks at the inlet of each induced draft fan. Dosages at the various points were varied as per instructions of the technical representatives.

During the period of treatment odor conditions in the countryside downwind from the mill were checked periodically. No strong kraft odors were noted, but traces of both the kraft odor and the aromatic odor were noted. The major drawback during this trial was the prevailing weather conditions. A shifting wind of from 5 to 15 m.p.h. was in effect, the sky was clear, and no smog was in evidence during the test. Based on this, it was decided that further trials of the masking materials would be necessary before valid conclusions could be reached regarding their effectiveness. The next trial was scheduled for the early part of 1952.

In the second trial, conducted in January and February of 1952, the same four types of the aromatic compounds were used. A check of the boiling ranges of the four types showed that each had a different temperature volatility curve. In an effort to get effective utilization of the different volatilities, various combinations of the four types were tried at each point of addition.

The trial was performed in four phases: the first phase involved addition of two of the aromatic mixtures in the recovery furnace stacks by means of an air injector atomizer; the second phase involved the treatment of the stacks only; the third phase involved treatment of the digesters and black liquor; and the fourth phase involved treatment of the digesters only.

Results of the treatments were checked by quality control personnel and the manufacturer representatives. In addition, a poll among clerical employees was conducted to further measure the effectiveness of the trial. The poll indicated a trend of fewer positive detections during the trial as compared to before and after. However, it was noticed that only a small percentage of those who participated actually smelled the paper mill odor either before, during, or after the masking trials.

Approximately 80% of the Tuscaloosa residential area is located in a quadrant with sides running southeast and southwest from the mill. A check of weather conditions during the trials revealed that wind direction was very changing but was primarily blowing away from this populated area. Also it is quite possible that a number of the participants in the poll were accustomed to the odor and, at times, not conscious of its presence. This in part would account for the small over-all reports of positive detection.

It was generally concluded that the four types of masking compounds were unsatisfactory for complete masking, but that a trend toward abatement of mill odors was noted. The best point of treatment appeared to be in the digesters. This conclusion was arrived at from opinions of persons directing and operating the odor control trials and has not yet been firmly proved. As a result of these trials it was also concluded that the boiling ranges of these odor masking compounds were too high for maximum effectiveness in the digester systems. The 50% boil-over point was above 400°F. It was decided that further tests were warranted, but that future trials would be held up pending the development of an improved type of odor masking compound.

GENERAL CONSIDERATIONS

The greatest difficulty in the field of odor abatement studies is the evaluation of results. There is no convenient yardstick by which conditions and variables may be measured. The variables involved are quite numerous and complicated making practical analysis almost impossible.

Here at this mill all work done to date has been from the angle of trial and error, relying on nose sensitivity for evaluating results. This is more reliable in the mill vicinity than at distances more than $^3/_4$ mile away. At distances of $^1/_4$ to $^1/_2$ mile downwind the odor from the digester turpentine recovery area can be distinguished from the recovery furnace area. At greater distances the various odors seem to have become mixed into one, making it difficult to distinguish which group is most predominant. The odors which are reported in the residential area are quite often mixtures of kraft mill, domestic, and other industrial odors.

On many occasions this mill has been blamed for emitting bad odors when, in fact, the complainants were actually the culprits. Approximately 50% of Tuscaloosa's domestic raw sewage runs into the Warrior River between this mill and a navigation dam just beyond the city. The pool above the dam acts as a good digestion basin emitting an untold quantity of hydrogen sulphide. The retention time in this pool varies inversely with river flow. Probably the most serious outflux of odor from this source is due to the following situation: during periods of low river flow all sewage and industrial waste tend to collect in this pool. The longer the low flow period the more concentrated the odors become in and around the river. The climax to this situation, though, comes with the first big rain up river. It is like flushing an oversize septic tank. Aeration of the effluent as it goes over the dam serves to liberate vast quantities of odorous gases. Should the weather conditions be such that wind velocity is nil, the relative humidity ranging from 50 to 90%, and temperature below 75°F., the odorous gases diffuse into

the residential areas near the dam. Local residents really put up a howl at times like this. Crews on riverboats traveling through are known to have become very nauseated as a result of these conditions. Of course the paper mill is blamed for it all.

No attempt has been made to evaluate this mill's liquid effluent as a source of odors. The writer has personally noticed the prevalence of turpentine and evaporater condenser water odors in the river downstream from the mill. Whether odors from these sources are of sufficient magnitude to be a nuisance is yet to be determined.

The black liquor recovery area is considered of secondary importance as a source of malodors at this mill. As mentioned previously the odor of this area can be picked up downwind near the mill. However, due to its magnitude and nature it is considered to be non-obnoxious. It is more or less the burnt odor common to most oil or coal burning furnaces.

PRESENT AND FUTURE OUTLOOK

At the writing of this paper the latest mixture of aromatic compounds is being tried at this mill. Addition is being made directly in the digesters as they are loaded. The producers worked on the formulation of this mixture for several months in an effort to make it best suitable for conditions at the digester. Each digester is given a 5-lb. dosage.

Results so far do not indicate complete abatement of odors under all atmospheric conditions. However, one odd change in conditions was noticed. While standing $^1/_4$ mile downwind from the digester area during a digester blow a faint vanilla odor was noticed along with the odor of steaming black liquor. If this is the result desired it will have to be multiplied approximately 50 times in order to effect appreciable abatement of odors.

Plans for the future include the use of this latest aromatic mixture but in a different manner. It is desired to determine what effect will be obtained by introducing the mixture directly into the gas-off relief line continuously and into the flash steam line from the cyclones during the digester blows. There is a possibility of the aromatic compounds reacting with the cooking liquor and subsequently being dissolved in the black liquor resulting in poor coverage of the relief gases during the cook. Work is already started toward the assemblage of adequate proportioning pumps for this trial which will probably be made sometime in December.

In the event the above trial proves unsuccessful, future work may be centered around some type of scrubbing system using bleach plant waste liquors. The literature indicates some degree of success has been met with this method. Scrubbing of turpentine condenser vent gases will be tried first. Should this prove successful, scrubbing of vent gases from the digester blow heat recovery systems will be considered.

Efforts toward odor abatement will be continued by Gulf States Paper Corp. until an improved method is found.

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Instrumentation of Recovery Furnaces

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The justification for instrumentation is to reduce operating costs and to maintain maximum efficiency of the process. This paper describes the instrumentation program as it has been developed at the Savannah plant of the Union Bag & Paper Corp. for their recovery system. The sequence followed in describing the applications is divided into six groups. First is the spent liquor preparation process, second, the combustion instrument accessories, third, the recovered chemical removal process instrumentation, fourth, the steam generating equipment instrumentation, fifth, the soot blowing equipment and sixth, the fume recovery instrumentation. The processes are described in some detail with certain recommendations as to instruments based upon mill experience.

History indicates that the beginning of the alkaline pulping processes dates back about 150 yr. and was first used in England for the treatment of linen or cotton rags, straw and other nonwoody fibrous materials for the production of paper. The quality of this pulp was poor and in 1851 the increasing need for paper stimulated the development of a method for pulping wood. This process did not receive commercial acceptance in England. Therefore, in 1854 Mr. Burgess, who had been instrumental in the development came to America where he set up his process using poplar chips as the raw material and sodium hydroxide as the digestion reagent. Due to the large quantity of alkali required, a partial recovery process was developed which involved incineration of the spent liquor.

In 1879 this process was modified by using caustic soda and sodium sulphide, the latter being a reduction product of sodium sulphate which was added as chemical make-up in the chemical recovery cycle. This reduced the production cost and produced a stronger pulp. The resultant product was known as kraft and was the beginning of the present industry.

One of the predominant reasons for good economy in the kraft process lay in the fact that efficient chemical recovery could be accomplished, thus making this method more attractive than the competitive sulphite process where chemical recovery was not practiced although the chemicals were somewhat cheaper.

Twenty years ago marked the beginning of enormous expansion in the production of alkaline pulp. Outstanding among the reasons which made this possible was the development of modern chemical recovery furnaces. Earlier equipment made no attempt to produce process steam with the waste heat from these

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furnaces which were designed primarily for chemical recovery. Early improvements involved the use of disk evaporators for final evaporation of the liquor before it was fed into the rotary furnaces and the addition of waste heat recovery boilers for the production of process steam. Various types of evaporator scrubbers were also used to further reduce the heat losses. The design of the modern recovery boiler has retained few

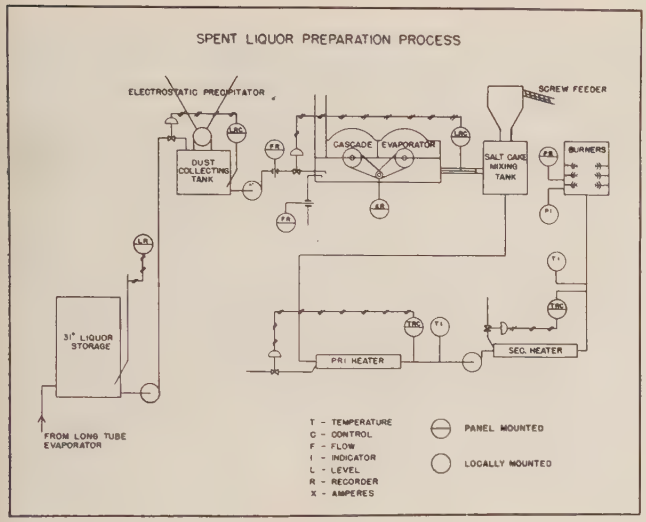

Fig. 1. Spent liquor preparation process

of the characteristics of its predecessors and has emerged a closely integrated and highly efficient unit with capacities ranging as high as 350 tons in 24 hr. It is obvious that economical operation of such large units requires the use of numerous automatic measuring and control devices.

It should be borne in mind that the justification for instrumentation is to reduce operating costs and to maintain maximum efficiency of the process. The purpose of the paper is to describe how this has been accomplished at the Savannah plant of Union Bag & Paper Corp.

In order to present this information in a reasonably logical sequence these applications will be divided into six groups, following first through the spent liquor preparation process, second the combustion instrument accessories, third the recovered chemical removal process instrumentation, fourth the steam generating instrumentation, fifth the soot blowing equipment, and last the fume recovery instrumentation (Fig. 1).

By referring to the figures which accompany this report, it will be noted that all instrument applications are shown by the use of symbols which have recently been accepted as standard by the Recommended Practices Committee of the Instrument Society of America and are explained in the figures.

SPENT LIQUOR PROCESS

The spent process liquor, after having passed through the long tube evaporators, enters a storage tank where it is ready for use in the recovery process. This tank is equipped with a bubble-type level recorder which is located on the recovery operating panel to continuously inform the boiler attendant of the trend and quantity of the liquor supply. A steam purge is available at the 2-in. diameter bubble pipe for occasional cleaning by the instrument maintenance personnel.

From this tank the liquor passes through the electrostatic precipitator dust collecting tanks. Here the level is regulated within close limits by a bubble-type recording level controller. Here again, the bubble pipe is of 2 in. diameter, this size having been found by experience to give the least plugging trouble. The recording element of the proportional control is of the mercury displacement type in order to provide adequate torque for operating the control mechanism. The control valve is placed in the input line to the collecting tank since the boiler demand controls the tank discharge rate. The control valves in all of the heavy liquor lines are subject to high corrosion and erosion rates and, therefore, must be made of special materials and designed to minimize impingement. Three and one-half per cent nickel iron bodies have proved quite satisfactory when equipped with a throttle plug-type inner valve with stainless steel trim. V-ported valves on heavy black liquor applications should be avoided because of their impingement characteristics.

The liquor, now containing the recovered dust, is pumped to the cascade evaporators. This flow is automatically controlled in a manner which will maintain relatively constant level in the cascades as well as a reasonably constant overflow to the saltcake mixing tank. An automatic valve similar to the one previously described is used in this line. Reasonable control can be accomplished by the use of a proportional-type temperature controller with the thermal bulb placed vertically in the cascade discharge trough. The center of the sensitive portion of the bulb should be

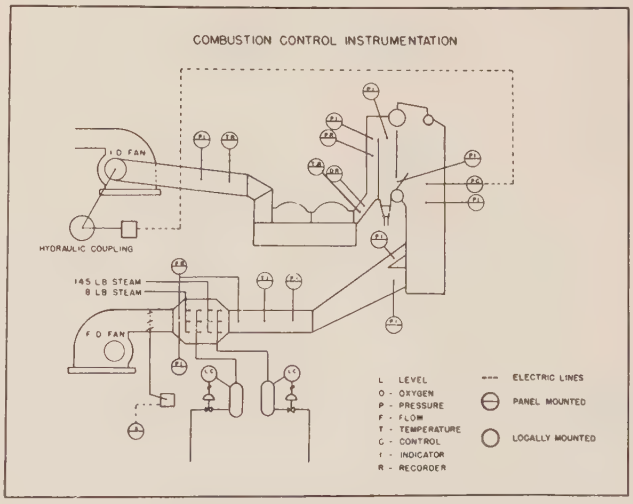

Fig. 2. Combustion control instrumentation

located at the desired liquor level and the control point set somewhat below the actual temperature of the liquor. The bulb should be located at a point in the trough where the liquor velocity is high enough to avoid build-up of solids on the bulb. This sytem, although reasonably good, has some disadvantages. The accumulation of solids on the thermal element can reduce the sensitivity to the point where extreme lag will

cause cycling of the control. Also any tendency of the induced draft control to swing will cause gas pressure changes in the cascade evaporator, thus producing an apparent change in level in the cascade. This will result in erratic control operation. It is of vital importance that the gas pressure in the cascades be maintained constant in order to avoid erratic liquor flow through the discharge seal to the salt cake mixing tank, as this condition cannot be corrected practically by any conventional level control.

The measurement of heavy liquor flow can be accomplished more easily in the liquor line to the cascade evaporators although the indications are not quite as valuable as measurements made directly ahead of the burners. In either case an orifice-type meter using a minimum displacement-type differential meter body of the pneumatic force balance type has been found to be the most satisfactory. The connecting orifice tap lines should be as short as possible and should be equipped, for occasional purging, with a small quantity of hot water or steam. Liquor temperature and density deviations from the meter specification can cause appreciable metering errors and should be taken into account if they exist.

From the cascades the liquor passes through the salt cake mixing tank where make-up chemicals are added from a variable speed screw feeder. Following the salt-cake mixing tank is the primary liquor heater which is of the direct steam-heated type. A thermal bulb placed in the liquor heater discharge line a short distance from the unit actuates the primary heater recording, proportional, temperature control. The maximum temperature at this point is limited by flashing at the suction of the pump following this heater. This

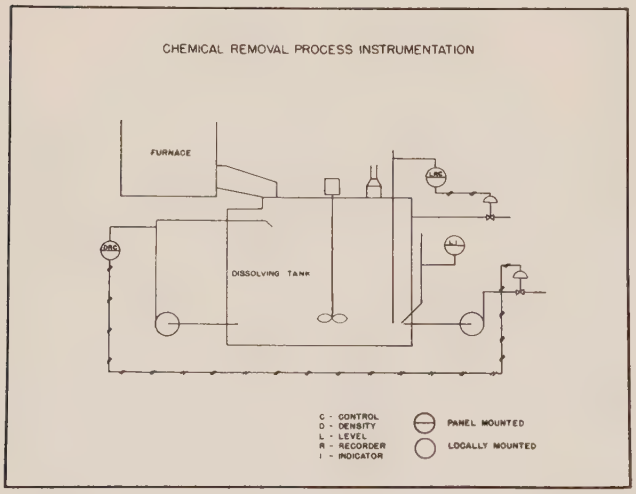

Fig. 3. Chemical removal process instrumentation

temperature should be maintained as high as good pump operation will permit. For instrument checking purposes an indicating industrial thermometer should also be installed in the liquor line near the control bulb.

The liquor pumps supplying the burners are of the variable speed type using remote manually set hydraulic couplings. Liquor burner pressure is of vital importance to the operator and is therefore continuously recorded at the main operating panel and is indicated at the burner location. A suitable oil seal is used on each of these gage lines and is placed as close as possible to the liquor headers.

Vertical location of the pressure tap on the top of the liquor header followed by an enlarged vertical riser will permit the use of a small continuous water purge entering the pressure line at the recorder. This system

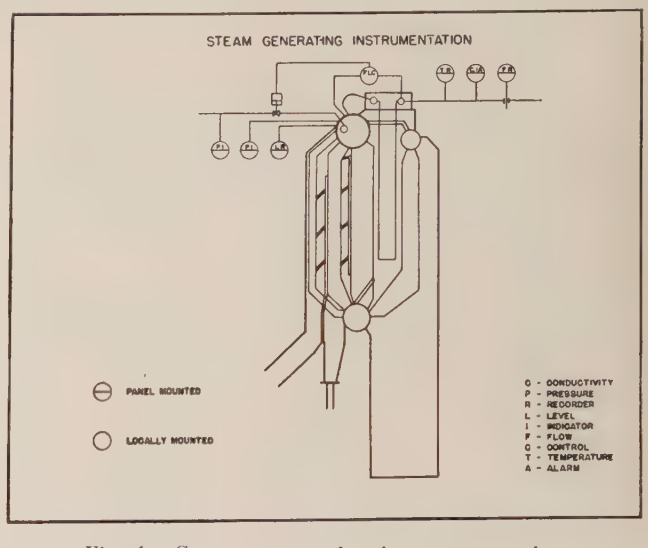

Fig. 4. Steam generating instrumentation

which replaces the oil seal will operate successfully for measuring moderately low burner pressures provided necessary precautions are taken to insure that the maximum permissible range of the recorder cannot be exceeded by the purge pressure.

Following the pump is the secondary heater which is controlled in a similar manner to the primary heater except in one respect. The burner liquor temperature is quite critical; therefore, a proportional controller with automatic reset is used.

In order to provide the operator with a reasonable indication of density of the liquor in the cascades, the drives are equipped with recording ammeters. It is important that these meters be calibrated so that the operating range will fall within the upper third of the chart. The instrument sensitivity in this range will give best response to small density variations.

Where the installation will permit the use of moderate quantities of weak liquor in the cascades, it is advisable to install a conventional orifice type flowmeter in this line. This will facilitate the manual control of the cascade liquor density as well as to provide data for the daily calculation of the efficiency of the unit.

All of the miscellaneous pressure gages on the liquor lines are provided with oil seals similar to those previously mentioned.

COMBUSTION CONTROL INSTRUMENTATION

Due to the operating characteristics of recovery boilers, the combustion control instrumentation is far less complex than will be found on a power boiler of similar size.

Referring to Fig. 2 it will be noted that the combustion air is supplied by a constant speed fan through

a remotely adjusted damper that can be set from the operator's panel. It then passes through an indirect finned coil heater. The pressure drop across this heater is used as an indication of air flow to the furnace and is recorded at the operator's panel. Thus, with the combination of the remote damper positioner and air flowmeter, the operator can readily adjust the total combustion air.

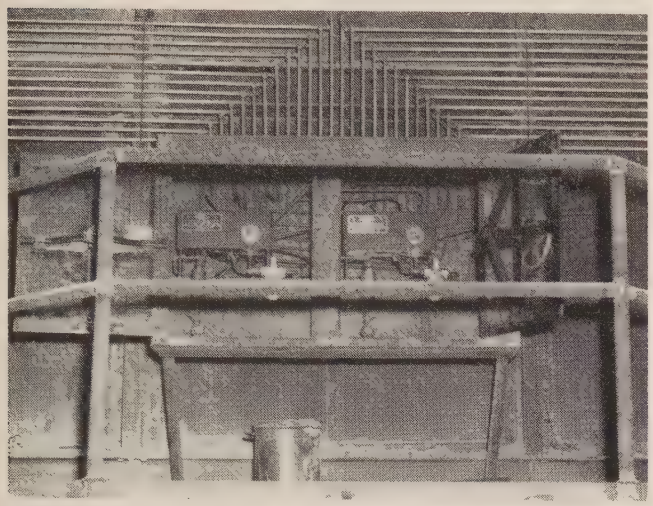

Fig. 5. Soot blower control installation

A portion of the heaters operate on 145 p.s.i. steam while the remaining sections operate at substantially lower pressure. Two condensate headers discharging into separate small collecting tanks are required. Pneumatically operated, float-type, level controls on each of these collecting tanks have been found far more satisfactory than numerous individual traps.

Related indicators installed on the operating panel include the air temperature from the heaters, the air heater inlet pressure, the main duct pressure, the primary air duct pressure, the secondary air duct pressure, the furnace draft, the first pass draft, the second pass draft, the third pass draft, and the evaporator outlet draft. The operator, therefore, is permitted at a glance to observe the condition of the boiler. Furnace draft connections must be of adequate size which is not less than 2 and, in some cases, 3 in. in diameter. A vertical riser from the draft tap of not less than 2 ft. is required in order to prevent excessive plugging of the connections. Air purge lines are provided at the panel for blowing down these draft lines periodically. Daily cleaning of the furnace draft and first, second, and third pass taps is usually required. Air purge piping should be so arranged that improper operation of the valves cannot permit overpressure damage to the draft gages.

The furnace pressure is maintained automatically at a negative pressure of 0.1 in. of water by an electric, inverted bell type low pressure controller. This device is so adjusted that a small deviation from the control point will send a short corrective impulse to the oil pump on the hydraulic coupling which regulates the speed of the induced draft fan. If the deviation is excessive, an impulse of longer duration is transmitted to the oil pump.

The boiler uptake draft is recorded continuously and gives the operator an over-all view of the condition of the passes. This record is also affected by the operation of the soot blowers and, therefore, indicates to him when the blowers are operating.

From the boiler outlet the furnace gases pass through the cascade evaporator. The inlet temperature to and the outlet temperature from the cascades are continuously recorded on the operator's panel. Nitrogen filled thermal systems have been used in the past for these applications but due to the short life and high cost of these systems, it is apparent that modern resistance-type or thermocouple-type instruments would be more economical.

Proper adjustment of the primary air is governed by the observed condition of the fuel bed but the correct regulation of the secondary air is not as easily determined. As a guide to this problem it is practical to use a suitable flue gas analyzer recording either oxygen or carbon dioxide content. The success of this application depends upon the sampling methods as plugged sampling tubes are sure to occur unless special precautions are taken. An automatic device for steam purging this tube for a few seconds during each hour has been used quite successfully.

CHEMICAL RECOVERY

The third group of instruments involves the removal of the dissolved smelt from the process. Until recently, the customary practice has been to pump weak wash liquor from the caustic process into the dissolving tank. The tank was allowed to remain full until the required concentration was reached and was then pumped out to the caustic process. Some of the disadvantages of this system were that large capacity pumps were required to handle this quantity of liquor rapidly and dependence was placed upon the operators to properly test the liquor and pump it out at the right time. From a practical standpoint this method may not produce uniform green liquor concentration. Additional personnel is required to operate such a system. One advantage is that the frequent alternation of weak and strong liquor in the dissolving tank does minimize tank

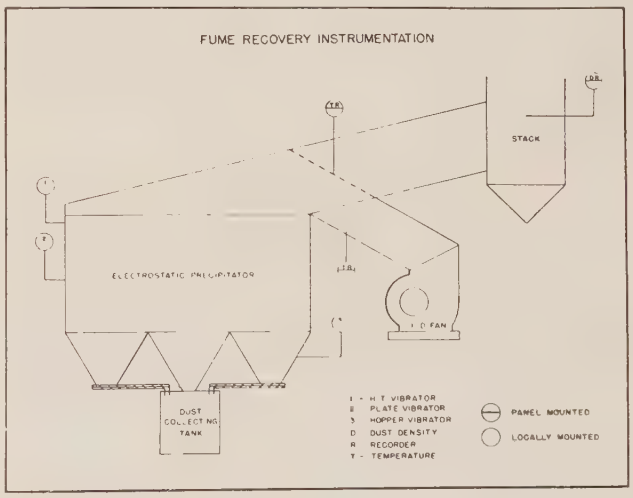

Fig. 6. Fume recovery instrumentation

deposits. Because of the disadvantages previously stated, the modern recovery installations are equipped with automatic controls to maintain a continuous flow through the dissolving tanks. This permits the use of smaller pumps and a more uniform concentration of liquor is discharged to the caustic process. Since the concentration is maintained at the maximum level the accumulation of tank deposits may become a problem unless an ideal agitating system is used. The instrumentation required for this method of operation includes a recording density control for regulating the discharge from the tank and a recording level control to regulate the fill-back flow into the tank. The primary measuring element for the level control is of bubble type quite similar to those previously described. The control mechanism is of the narrow band proportional type. Both instruments are located on the operator's control panel. Numerous devices have been used to measure the density of the green liquor but none have been found, so far, that are completely successful. Some of these devices will work but the maintenance requirements are high. The differential bubble-type unit has been reasonably successful but if the primary elements are located in the tank they are subject to frequent mechanical damage. If the primary elements are located remotely, frequent plugging of the sample line may result. Sample lines taken from the recirculating pump discharge lines have been most successful. Satisfactory sampling will permit the use of a displacement-type force balance transmitter in conjunction with a standard controller with the buoyant element designed for fast easy cleaning. It must be kept in mind that the reason for the use of this type of dissolving tank control is to supply the caustic plant with green liquor of uniform concentration. Therefore, the instrument just described is the key to the success or failure of the system. The discharge control valve is subject to corrosive and erosive action; therefore, cast-iron valve bodies are unsatisfactory. Nickel iron is reasonably successful but the best results can be expected with stainless steel. Here again, impingement must be avoided in the design of the inner valve.

BOILER INSTRUMENTS

The fourth group includes the boiler instruments. A conventional flowmeter is provided for recording the flow of steam generated. Comparison between this record and the black liquor flow record will give the operator a reasonable check on the efficiency of the furnace and boiler operation. Since the liquor meter is subject to error due to variations in the characteristics of the liquor being burned, the value of this comparison is somewhat limited unless the liquor conditions are held substantially constant.

A record of the superheated steam temperature, a steam drum pressure gage, and a feedwater pressure gage are provided on the operator's panel. Records of the two latter variables are recorded elsewhere and, therefore, need not be repeated at this panel. A drum level recorder is included, and the feedwater is controlled by a conventional two-element blind regulator. Although the recovery boilers are not equipped with recording, three-element, drum level controls, they are in use on one of the plant power boilers and are giving exceptionally good service. It is reasonable to believe that they would give equally good service on the recovery units.

Where there is an indication that occasional carry-over may be troublesome it is advisable to monitor the steam quality with a conductivity recorder or indicating alarm system. This is done in a conventional manner by condensing a small sample of the generated steam. Although it is preferable to degas the sample before measurement for precise work, a very useful measurement may be made directly on the discharge from a small condenser. The conductivity of the degassed sample, however, will be slightly lower.

CONTROL OF SOOT BLOWERS

The fifth group of instruments control the operation of the soot blowers. This is a combination of a number of air puff units and retractable steam blowers. The air puff system is equipped with its own air compressor operating at 320 p.s.i. The cycle can be started directly from the operator's panel. The retractable blowers are supplied with steam from the drum and are also operated in sequence directly from the main panel. The operation of the complete soot blowing cycle requires only one brief operation on the part of the boiler attendant. Maintenance requirements on this equipment are reasonably small. Proper initial installation is of paramount importance in this respect. Part of the control equipment must be located remotely close to the boiler and must be protected in a suitable enclosure for best results. The associated control piping must also be installed with great care. Copper tubing, usually supplied, has been found to be most unsatisfactory and has been replaced with standard $^3/_8$-in. galvanized pipe.

FUME RECOVERY

Last but not least, the fume recovery system does require some important instrumentation. All of the recovery units are provided with electrostatic precipitators. Dust removal from the electrodes is accomplished by the use of automatic sequentially operated pneumatic rappers. Each rapper is supplied with compressed air from individual pressure regulators.

The rapping sequence and duration is of critical importance and should be kept to a minimum for good precipitator operation since the dust losses increase sharply during the rapping operation.

In order to minimize corrosion it is necessary to maintain duct temperatures within certain limits. This is monitored by a thermocouple-type recording potentiometer with primary elements located in the inlet duct to and outlet duct from the precipitators.

The efficiency of the dust collecting system is continuously monitored by a dust concentration recorder, the primary element of which is located in the base of the precipitator discharge stack. This device measures the infrared light transmittance of the exit gases and, although it is a recent installation, it is giving suprisingly good results.

Further instrumentation of the recovery unit includes numerous pressure gages and industrial indicating thermometers. Also, temperature elements of the thermocouple type are installed in the fan bearings and are included in a 160-point recording alarm system

located in the main turbine room of the plant. Alarms are set to operate when abnormal temperatures exist.

It may be easily seen from this report that instrumentation is playing a most vital part in the operation of this modern recovery unit. We feel that we have made important strides in the accomplishment of our objectives, thus helping to provide maximum recovery capacity and efficiency with a minimum operating cost.

RECEIVED Nov. 10, 1952. Presented at the Sixth Alkaline Pulping Conference of the Technical Association of the Pulp and Paper Industry, Mobile, Ala., Nov. 14–16, 1953.

Submerged Combustion Evaporation

WILLIAM I. WEISMAN

Submerged combustion is defined. The components and functioning of a submerged combustion evaporator are described. The advantages of this method result because heat transfer is direct from products of combustion to solution. It is particularly applicable to solutions with scaling characteristics, high viscosity, high boiling points, or corrosiveness. Limitations arise from necessity of gaseous fuel or relatively expensive oil, and the inability to perform as a multiple effect. Possible uses in the pulp and paper industry are in mills with insufficient steam generating capacity and in waste disposal problems. For evaporation of black liquor, submerged combustion may have merit for reaching high concentrations of solids after preconcentration by conventional multiple effects. It is suggested that pilot-plant work on this application may be of value.

ALTHOUGH submerged combustion evaporation has been done commercially for over 15 years, it has been in the last few years only that industry has become aware of the potential value of this tool (*1*). The method has outstanding advantages for certain difficult evaporation problems, but also has definite limitations. These will be reviewed and possible applications in the pulp-and-paper industry will be suggested.

DESCRIPTION OF COMPONENTS

True submerged combustion has been defined as "burning a gaseous fuel in a special burner submerged completely beneath the surface of a liquid." To accomplish this, the gaseous fuel and the combustion air must be introduced to the burner in such a way as to avoid combustion until they are submerged completely and then to maintain the flame at this point. In the burner manufactured by the Ozark-Mahoning Co., air and gas are mixed before being introduced to the burner. Combustion of the air-gas mixture prior to entering the burner is prevented by maintaining in the leader tube to the burner a velocity which will exceed the flame velocity or rate of flame propagation for this air-gas mixture. In the burner itself the mixture velocity falls below the flame velocity so that combustion can take place.

This can be understood better by referring to a diagram of a typical submerged combustion unit (Fig. 1), which consists of the following components:

1. A positive pressure-type blower to deliver the required combustion air to the burner, with suitable drive.
2. The burner assembly, which includes an electrical igniter, the air-gas mixing device, interconnecting piping, valves, regulators, and similar accessories.
3. A tank which holds the liquid being processed, and a suitable vapor stack.

Not shown in Fig. 1 is the fourth component, the control panel, on which are mounted gages, switches, and instruments. If manual control is adequate only rather simple instruments are needed; if fully automatic controls are desired, the instrumentation, depending on the variable used to control heat output, may be fairly complex.

ADVANTAGES

The outstanding advantage of the submerged combustion evaporator stems from the fact that the transfer of heat is direct from the products of combustion to the solution being evaporated without the necessity of using a heat transfer medium, such as steam, or the transfer of heat through surfaces such as boiler tubes and evaporator tubes.

The gases leave the burner in the form of many small bubbles which provide a tremendous surface for heat transfer. Hence, the transfer of heat is very rapid and complete. Experience has proved that if the burner is completely submerged the gases on leaving the solution will be cooled to the same temperature as that of the solution. Obviously, under these conditions high thermal efficiencies must result.

Several types of solutions are difficult to evaporate in conventional tube-and-shell evaporators. One of these is the solution that forms scale on the tubes. Scale decreases the rate of heat transfer with consequent loss of capacity. Frequent and expensive shutdowns may be needed to remove scale. In a submerged combustion evaporator this characteristic of the solution does not affect the capacity or operation, because no heat transfer surfaces on which scale can form are present.

Another type of solution which may exhibit a low coefficient of heat transfer through tubes is one having high viscosity. Submerged combustion can handle these solutions without difficulty in the usual evaporation problem, but of course cannot be used to dry a solid of high moisture content.

Also, solutions with high boiling points are difficult to evaporate in vacuum evaporators, but present much less difficulty in submerged combustion evaporation. In evaporating these solutions by submerged combustion some slight decrease in thermal efficiency can be expected because the combustion gases are discharged

WILLIAM I. WEISMAN, Chemical Engineer, Ozark-Mahoning Co., Tulsa, Okla.

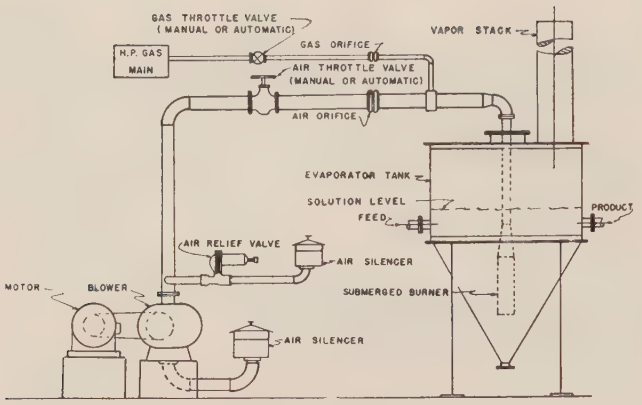

Fig. 1. Schematic sketch of typical submerged combustion installation

at a higher temperature; radiation losses are also higher.

Corrosive solutions usually present a problem for tube evaporators because expensive alloys are required for tubes and replacement may be frequent and costly. In contrast, only the burner of a submerged combustion unit is subject to the severest corrosive conditions; a graphite burner design which may have long life in many corrosive solutions has been developed.

LIMITATIONS

The definition of submerged combustion which was given, limited the fuel to gaseous materials. Natural gas may not be readily available in some areas and hence fuels like propane or butane may serve. For many problems these fuels are expensive and the cost of fuel may outweigh the advantages which warranted consideration of submerged combustion.

One of the development problems which has received a great deal of attention has been the burning of oil. It has been learned that oil, if properly vaporized before combustion, can be burned successfully. Thus the fuel in the burner is in the gaseous state and the conditions of the original definition of submerged combustion are fulfilled.

Full-scale plant tests have been made with satisfactory results on the burning of fuel oil by submerged combustion. It was found, however, that a high-grade fuel oil is required with the type of vaporizer used, which establishes somewhat similar limits to those arising when using propane or butane.

Another limitation which is quite obvious is the inability to use a multiple-effect system with submerged combustion. It is possible, however, to utilize much of the latent heat in the vapors from the stack and some installations have been designed to include such facilities.

POSSIBLE APPLICATIONS IN THE PULP AND PAPER INDUSTRY

Because of this last limitation, application of submerged combustion in the pulp and paper industry may encounter obstacles. Nevertheless, certain possibilities seem to be worth while of suggestion because conditions within individual plants may vary sufficiently that submerged combustion should be considered for specific situations. Thus, in the case of the plant which may find itself with insufficient steam generating capacity, the use of submerged combustion to take care of part of its evaporation load could make available steam for other uses. The relatively low capital cost makes submerged combustion attractive under these conditions.

Another example would be for heating water where waste steam is not available.

Submerged combustion has been found quite suitable for evaporation of various waste liquors and a number of installations have been made for such service (*2*, *3*). The comparatively low capital cost makes submerged combustion attractive and the much lower maintenance costs that result from continuous operation without the need of shutting down to clean out scale may very well overweigh the additional fuel costs as compared to multiple-effect evaporators.

Recently pilot-plant work was performed in cooperation with the National Council for Stream Improvement on the submerged combustion evaporation of neutral sulphite semichemical waste liquor. The results have been released to the members of the council in a technical bulletin. The conclusions drawn from this preliminary test generally are in agreement with the statements above. Capital cost for the submerged combustion equipment is much lower than for a quadruple-effect unit but fuel and power costs are considerably higher. The maintenance factor was not taken into consideration directly, but conceivably could be of significance and would depend on whether the concentrated liquor would scale badly on tubes.

The possiblity of utilizing submerged combustion for evaporation of kraft mill black liquor was suggested several years ago and has been given some consideration. Because our personnel were not familiar with the industry, a consulting engineer was called in and several reports were submitted by him. The gist of these reports was that submerged combustion would not be economical for the concentration of black liquor up to 45 or 50% solids compared to conventional multiple-effect evaporation; however, it may offer some marked advantages in concentrating from about 45% solids up to 65% solids. It was pointed out that a high concentration of solids results in more economical operation of the chemical recovery furnaces and it was the opinion of the consultant that such concentration might be achieved more readily by the use of submerged combustion than by other types of equipment.

To verify these opinions it is evident that pilot-plant work must be done. The only work that has been carried out on black liquor might be designated as preliminary tests. From these tests it has been shown that problems of foaming and precipitation of lignin and humus might present some difficulty. Reasonable hope exists, however, that such problems could be solved through additional pilot-plant work.

The author is not qualified to state with certainty that submerged combustion has or has not a place in the pulp and paper industry. However, it has proved to be a useful tool for a number of difficult evaporation tasks.

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Received Nov. 3, 1952. Presented at the Sixth Alkaline Pulping Conference of the Technical Association of the Pulp and Paper Industry, Mobile, Ala., Nov. 14–16, 1952.

ASSOCIATION NEWS AND EVENTS

Report of Nominating Committee

The TAPPI 1954 Nominating Committee consisting of Nicholas Shoumatoff, West Virginia Pulp & Paper Co., New York, N. Y., chairman; R. H. Hurst, Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich.; Charles H. Krebs, Atlas Boxmakers, Inc., Chicago, Ill.; John P. Weidner, Container Corp. of America, Manayunk, Pa.; and Fred J. Weleber, Publishers Paper Co., Oregon City, Ore., have presented the following nominees for officers and executive committeemen to be voted on by the Association membership prior to the TAPPI Annual Meeting in 1954:

President (one year): George H. Pringle, Mead Corp., Chillicothe, Ohio.

Vice-President (one year): Karl O. Elderkin, Bowaters Southern Paper Corp., Calhoun, Tenn.

Executive Committeemen (three years): Roy L. Davis, Detroit Sulphite Pulp & Paper Co., Detroit, Mich.; Ward D. Harrison, Riegel Paper Corp., Milford, N. J.; Fleming D. Long, Container Corp. of America, Manayunk, Pa.; Robert I. Thieme, Scott Paper Co., Anacortes, Wash.

Note: Article VII, Sec. 3, TAPPI Constitution: "Other nominations, if signed by at least 25 voting members, may be submitted to the Secretary of the Association, in writing, on or before November 20, and if each nomination so made is accepted in writing by the nominee, the name shall be placed on the official ballott."

Testing Conference

The TAPPI Testing Conference will be held at the Battelle Memorial Institute, 505 King Ave., Columbus, Ohio, on Sept. 21–23, 1953.

To date only the TAPPI-ASTM Technical Committee on Petroleum Wax and the TAPPI Paper Testing Committee have indicated that they will hold sessions to discuss testing procedures.

Room reservations should be made direct with the Neil House, Columbus, Ohio.

A. M. Heald of the Scott Paper Co., Chester, Pa., is chairman of the TAPPI Wax Testing Committee and D. H. Newcomb of the Riegel Paper Corp. is chairman of the TAPPI Paper Testing Committee.

Other committees of the Association are welcome to use the meeting room facilities of the Battelle Memorial Institute. Chairman of such committees should communicate with Samuel A. Woodruff at the Institute so that arrangements can be made to accommodate their groups on either September 21, 22, or 23.

Plastics Conference

The TAPPI Plastics Conference will be held in Marshall Hall at the College of Forestry, State University of New York, Syracuse, N. Y., on Sept. 15–16, 1953. Ralph T. Nazzaro of the Westfield River Paper Co., Russell, Mass., is chairman of the sponsoring Plastics Committee.

Following is the tentative program of the conference.

Tuesday, September 15

9:30 a.m. FUNDAMENTAL PAPERS SESSION

HERMAN MARK, Polytechnic Institute of Brooklyn, Brooklyn, N. Y., *Chairman*

1. "Resinography," by T. G. Rochow, American Cyanamid Co., Stamford, Conn.
2. "Block and Graft Polymers," by R. B. Mesrobian, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

10:30 a.m. SPECIAL RESINS SESSION

3. "Epoxy Resins," by T. F. Bradley, Shell Development Co., Emeryville, Calif.
4. "Progress in the Polyester Field," by F. R. Eirich, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.
5. "Modified Polymers Containing Fluorine," by H. S. Kaufman, M. W. Kellogg Co., Jersey City, N. J.

2:00 p.m. PANEL DISCUSSION ON FUNDAMENTAL PAPERS AND SPECIAL RESINS

Wednesday, September 16

9:30 a.m. GENERAL SESSION

JOSEPH C. PULLMAN, American Cyanamid Co., Stamford, Conn., *Chairman*

1. "Plasticizers—Their Use in Paper Coatings," by H. S. Bergen and J. R. Darby, Monsanto Chemical Co. Springfield, Mass.
2. "Recent Developments in the Use of Plastics in Paper in Europe," by H. Mark, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.
3. "The Use of Inorganic Synthetic Fiber Paper for Laminates," by H. F. Arledter, Hurlburt Paper Co., South Lee, Mass.
4. "Experimental Roll Coating, Polyethylene-Wax Blends," by G. L. Booth, Dilts Machine Works, Fulton, N. Y.

2:00 p.m. PANEL DISCUSSION OF PAPERS PRESENTED IN THE MORNING SESSION

Note: A block of rooms has been reserved at the Onondaga Hotel, Syracuse, N. Y., for the evenings of September 14 and 15. Individual reservations should be made direct with the hotel. Be sure to mention the TAPPI Plastics Conference.

Tenth Fibrous Agricultural Residues Conference

The Tenth Fibrous Agricultural Residues Conference will be held at the Quint Hotel, Belleville, Ont., on Oct. 9–10, 1953. (Note change in location. This conference was previously scheduled to be held in Trenton, Ont.)

The meeting will be devoted to a consideration of "Crush Resistance and Other Properties of Strawboard." S. I. Aronovsky is chairman of the TAPPI Fibrous Agricultural Residues Committee sponsoring the conference.

There will be an inspection tour of the Hinde & Dauch Paper Co. of Canada Ltd. at Trenton, Ont., on Friday, October 9.

Third Corrugated Containers Conference

The Third Corrugated Containers Conference will be held at the Statler Hotel, New York, N. Y., on Oct. 15–16, 1953. It will be sponsored by the TAPPI Corrugated Containers Committee, Burt Mendlin, Cornell Paperboard Products, Inc., Milwaukee, Wis., chairman.

The Conference Arrangements Subcommittee consists of Keith Max, Robert Gair Co., New York, N. Y., chairman; W. W. Fitzhugh, Jr., Wm. Fitzhugh, Inc., Brooklyn, N. Y.; J. P. Greiveldinger, Robert Gair Co., New York, N. Y.; T. J. Gross, Union Bag & Paper Corp., New York, N. Y.; E. A. Taub, Gibralter Corrugated Paper Co., North Bergen, N. J.

Meetings of the subcommittee were held on May 7 and July 15. The papers and discussions at the conference will be devoted to a consideration of "Printing on Corrugated Containers."

The preliminary program for the technical program of Thursday, October 15, is as follows:

1. "Four Color Printing, Aniline Developments, Fountain Modifications, and Distribution Rolls, with Special Emphasis on Equipment and Technique," by E. B. Seeger, Samuel M. Langston Co., Camden, N. J.
2. "The Relationship of Printing on Corrugated Boxes to Advertising and Sales, Package Engineering and Production; Half-Tone Printing, Plate Thickness and Hardness; Effect of Ink Types on Dies," by Paul Fitzsimmons, James H. Matthews Co., New York, N. Y.
3. "A Descriptive Analysis of Oil-Base Aniline, Moisture-Set, and Fluorescent Inks; Including the Uses, Limitations, and Advantages, Gloss Characteristics," by W. E. Montoux, Sinclair & Valentine Co., New York, N. Y.

In the afternoon session the speakers will discuss the printing operations from the standpoint of practical production, the effect of functional properties, and customer requirements.

4. "Press Scheduling, Setups, Make-ready, and Press Adjustments," by Stanley Baughman, Container Corp. of America, Manayunk, Pa.
5. "Press Operations, Wash-up and Maintenance" (speaker to be announced).
6. "The Effect of Printing on Container Functional Properties," by A. W. Hoffman, Container Laboratories, Inc., New York, N. Y.
7. "Customer Requirements and Expectations of Printing on a Corrugated Box," by Paul Smith, Scott Paper Co., Chester, Pa.

The morning and afternoon sessions will be completed by question-and-answer periods.

On Thursday evening the ink manufacturers will be host at a get-together party which will be followed by a banquet at which "Doc" William Sims will be the featured professional entertainer.

The program for Friday, October 16, will feature inspection tours of corrugated container plants in the New York Metropolitan Area. Details will be announced later.

Eighth Engineering Conference

The Eighth TAPPI Engineering Conference will be held at the Sheraton-Mount Royal Hotel, Montreal, Que., on Oct. 26–29, 1953. Charles J. Sibler of the West Virginia Pulp & Paper Co., New York, is general chairman of the TAPPI Engineering Div., sponsor of the conference.

Following is the revised program.

Monday, October 26

8:30 a.m. Registration (Foyer)

9:15 a.m. General Session (Champlain Room)
C. J. Sibler, *Chairman*

Address of Welcome

9:30 a.m. Hydraulics Session (Champlain Room)
K. J. Mackenzie, Eastman Kodak Co., Rochester, N. Y., *Chairman*

"Progress Report on Pipe Friction Studies," by R. E. Durst, University of Maine, Orono, Me.

11:00 a.m. Engineering Research and Machine Design Session (Champlain Room)
J. D. Lyall, Armstrong Cork Co., Lancaster, Pa., *Chairman*

"Constant Tension Devices," by George C. Ehemann, Jr., Ohio Boxboard Co., Rittman, Ohio, and R. C. Berger, General Electric Co., Cleveland, Ohio.

"The Application Aspects of Paper Machine Differential Drives," by Sterling Skinner, Beloit Iron Works, Beloit, Wis.

"The Mechanics of Stress and Strain Occurring in a Fourdrinier Wire," by John D. Lyall, Armstrong Cork Co., Lancaster, Pa.

12:30 p.m. Engineering Division Luncheons

Drying and Ventilating Committee
Materials Handling Committee
Mill Maintenance and Materials Committee
Chemical Engineering Committee

2:00 p.m. Electrical Engineering Session (Champlain Room)
R. W. Foster, Champion Paper & Fibre Co., Canton, S. C. *Chairman*

"Grounded vs. Ungrounded Power Systems—A Demonstration. Review of Operating Experiences," by George P. Hobbs, Bowaters Newfoundland Pulp & Paper Mills Ltd., Corner Brook, Nfld., and R. H. Kaufmann, General Electric Co., Schenectady, N. Y.

"An Engineering Analysis of Downtime of Electric Section Drives," by R. F. Sorenson, Union Bag & Paper Corp., Savannah, Ga.

3:45 p.m. Discussion Meetings

Hydraulics

Discussion of TAPPI Research Project at the University of Maine on Pipe Friction Studies.

Engineering Research and Machine Design

Discussion of papers presented.

Electrical Engineering

"Selection of Chipper Drives" (Preliminary Report), by M. J. Osborne, Bowaters Southern Paper Corp., Calhoun, Tenn.

Discussion of Cable Reports, by A. O. Mortenson, St. Regis Paper Co., Pensacola, Fla.

Dinner (where you will)

Tuesday, October 27

9:00 a.m. Drying and Ventilating Session (Champlain Room)
Curt A. Young, Riegel Paper Corp., Milford, N. J., *Chairman*

"Rate of Drying Through Paper Machine Driers," by A. E. Montgomery, J. O. Ross Engineering Corp., Chicago, Ill.

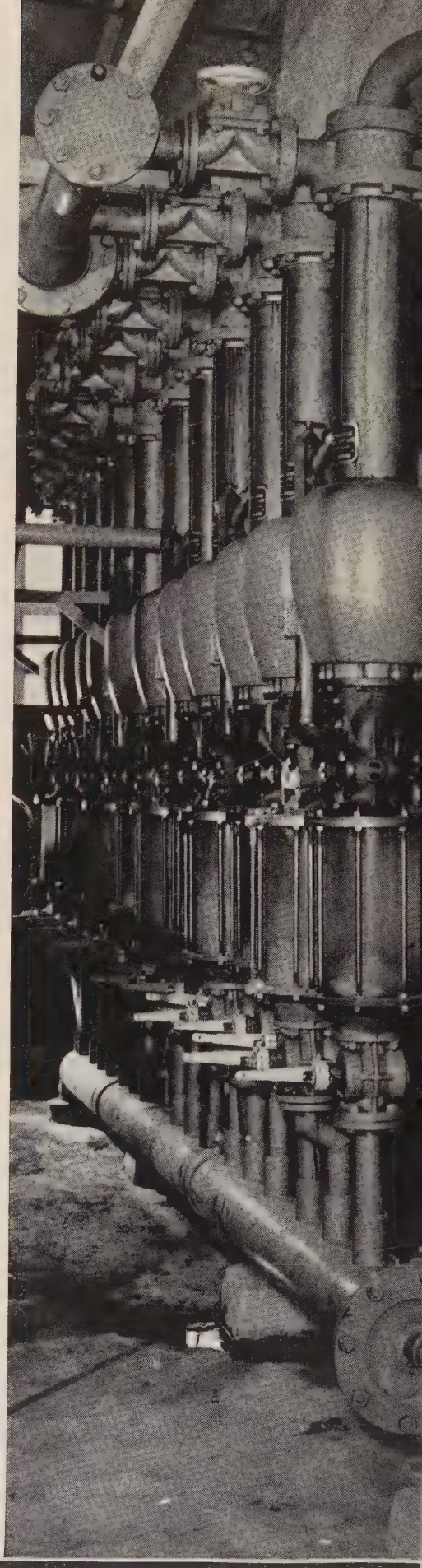
10:30 a.m. Materials Handling Session (Champlain Room)
A. P. Schnyder, Ebasco Services, Inc., New York, N. Y., *Chairman*

"Use of Gasoline vs. Electric Trucks in the Paper Indus-

When you put up a barrier to paper dirt, why not put up the *best* and *strongest*- the DIRTEC

Half way measures for removal of foreign particles from paper stock aren't enough. Today's demands for both quality and quantity call for the most efficient, best engineered, best constructed units available — that means DIRTECS.

Ask us to prove it



BIRD MACHINE COMPANY

South Walpole • Massachusetts

try," by R. F. Weber, International Harvester Co. Chicago, Ill.

"Economics of Various Methods of Handling Mill Supply Chemicals," by H. A. Stoess, Jr., Fuller Co., Catasauqua, Pa.

12:30 p.m. Engineering Division Luncheons

Hydraulics Committee
Engineering Research and Machine Design Committee
Electrical Engineering Committee

2:00 p.m. Mill Maintenance and Materials Session (Champlain Room)

H. F. Parker, New York & Pennsylvania Co., Lock Haven, Pa., *Chairman*

"The Maintenance of Bleach Plant Equipment," by Harold H. Huseby, Northwest Paper Co., Cloquet, Minn.

"The Application of Noncorrosive Materials," by George Lydick, Beckett Paper Co., Hamilton, Ohio.

3:30 p.m. Discussion Meetings

Drying and Ventilating
Materials Handling
Discussion of "Economics of Various Methods of Handling Mill Supply Chemicals."
Mill Maintenance and Materials
"Maintenance of Pipe Lines—Internal Cleaning," by Carl W. Ziegenbusch and M. V. Jones, Mead Corp., Chillicothe, Ohio.

6:00 p.m. Social Hour (Champlain Room)

7:30 p.m. Dinner (Ball Room)

B. K. Sandwell, Toronto, Ont., *Speaker*

Wednesday, October 28

9:00 a.m. Digester Corrosion Session (Chemical Engineering) (Champlain Room)

J. R. Lientz, Union Bag & Paper Corp., Savannah, Ga., *Chairman*, Chemical Engineering Committee, and Nicholas Shoumatoff, West Virginia Pulp & Paper Co., *Chairman*, Digester Corrosion Subcommittee, *Co-Chairman*

"Comparative Analysis of Digester Corrosion Measurements," by T. E. Caywood, Armour Research Foundation, Chicago, Ill.

"Promising Indications of Causes of Corrosion in Alkaline Pulping Equipment," by Claud B. Christiansen, Pulp and Paper Research Institute of Canada, Montreal, P. Q.

"Safety Evaluation and Protection of Digesters," by W. B. Parker, Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn., and H. M. Canavan, Mutual Boiler and Machinery Insurance Co., Boston, Mass.

10:30 a.m. Mill Design and Economic Aspects Session (Champlain Room)

R. A. Packard, Mutual Security Agency, Washington, D. C., *Chairman*

"Fire Protection in Pulp and Paper Mills," by R. C. Max, Factory Insurance Association, Milwaukee, Wis.

"Pulp and Paper Mill Building Construction in Canada," by F. M. Kraus, Stadler, Hurter & Co., Montreal, P. Q.

12:30 p.m. Engineering Division Luncheon

Charles J. Sibler, *Toastmaster*

"The Urgent Needs of the Industry," by Douglas W. Ambridge, Abitibi Power & Paper Co., Ltd., Toronto, Ont.

2:30 p.m. Steam and Power Session (Champlain Room)

W. M. Wyburn, Federal Paper Board Co., Inc., Bogota, N. J. *Chairman*

"The ASME Boiler Code and Its Application in the United States and Canada," by E. C. Korten, Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn.

"Case History on the Topping Turbine Installation at the St. Regis Paper Co.," by H. R. Emery, St. Regis Paper Co., Deferiet, N. Y., and P. H. Nelson, Chas. T. Main, Inc., Boston, Mass.

3:45 p.m. Discussion Meetings

Digester Corrosion
Discussion of session papers.
Mill Design and Economic Aspects
Discussion of paper presented.
Steam and Power
"Interpreting Performance Curves of Single- and Double-Extraction Turbines and the Use of Heat Rates as a Method of Calculating Power Costs," by J. Gottlieb, Westinghouse Electric Corp., New York, N. Y.

7:00 p.m. Dinner Meeting for Committee Chairmen and Secretaries

Review of the 8th Engineering Conference
Discussion of the 1954 Conference
Review of Engineering Division Projects
TAPPI Engineering Data Sheets

Thursday, October 29

9:00 a.m. Plant Inspection Tour Dominion Engineering Co., Montreal, P. Q.

Arrangements will be made to visit other industrial plants of particular interest to individuals.

What You Should Know About the TAPPI Engineering Conference

W. C. Bloomquist*

An outsider attending his first TAPPI Engineering Conference usually gets the surprise of his life. It's different—very different from the usual technical meeting. His first impression is the high percentage of attendance at meetings; second, the seriousness of the entire conference; and third, the frank discussion and exchange of ideas—knowledge and education.

This article, a brief summary of the activities of the Engineering Division but more specifically of the annual Engineering Conference, is directed to management so they will know how they benefit by sending representatives, and to mill engineers so they will know what to expect at the conference.

What is the purpose of the TAPPI Engineering Conference, who attends, and what does he get out of it?

The activities of the Engineering Division are directed primarily toward improvement and design and construction in addition to day-to-day operations of pulp and paper mills. With the many technological changes, increased machine speeds and production, trend toward more automatic operations and control, use of electronic equipment, and the never ending introduction of new products and machinery, individuals and mills must keep abreast of developments or fall by the wayside.

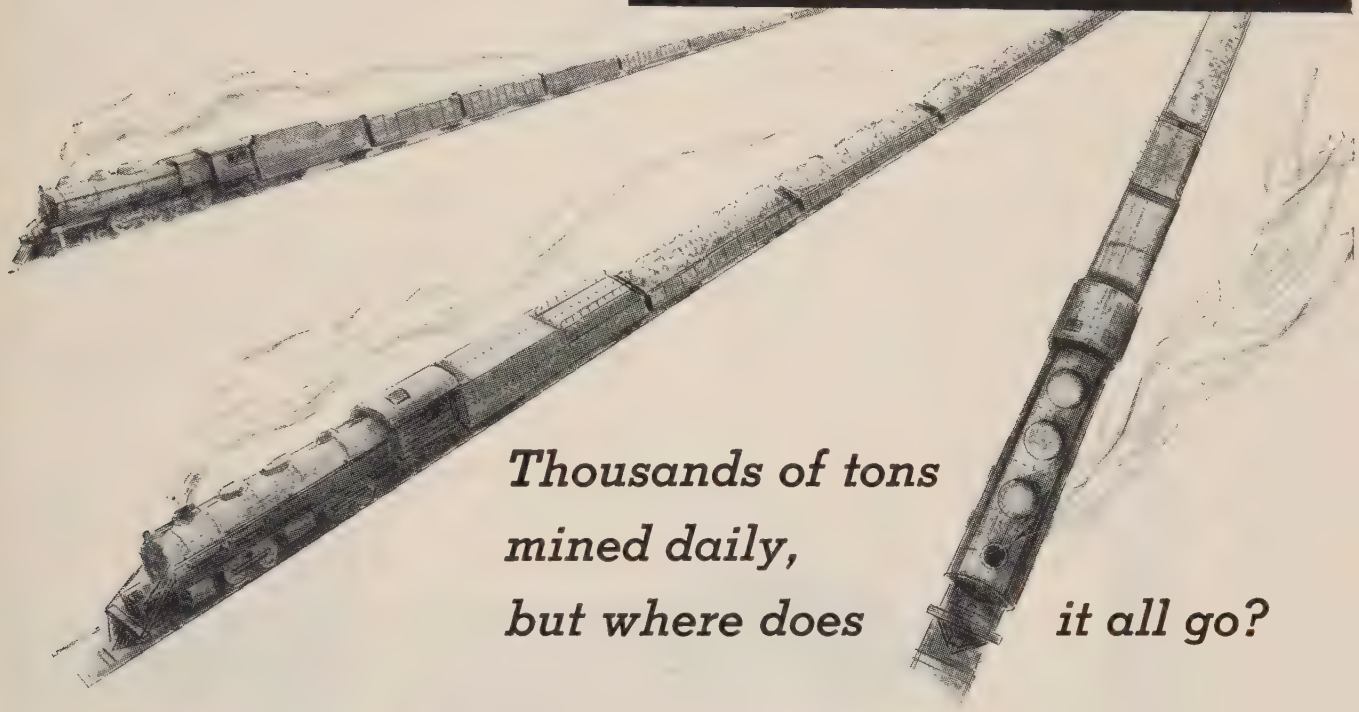
The success of the paper industry is based on the free exchange of ideas on technical and operating developments, and the Engineering Division encourages that approach.

History of TAPPI Engineering Division

Did you know that TAPPI was started along the lines we now know of as the Engineering Division activities? In the early days machine speeds were low, mechanical and electrical systems simple, and maintenance problems relatively easy. The more pressing mill problems those days concerned the chemistry of paper and soon that became the major activity along with the development of Standards.

*W. C. Bloomquist, Secretary, TAPPI Engineering Division.

Sulphur



Thousands of tons mined daily, but where does it all go?

LOOK AROUND YOU and let your glance fall on any object. The chances are 1000 to 1 that sulphur played an important role in its manufacture, either as a component part of the finished product or as a processing element.

Take, for example, the very magazine you are reading. If it's average size it weighs about 1 pound. Made largely of sulphite pulp it required about 0.1 pounds of sulphur in its manufacture.

Multiply this 0.1 pounds of sulphur by the thousands of magazines turned out every day and you'll get some idea of the tremendous tonnage of sulphur required for this *single* division of industry . . . the sulphite pulp manufacture.

Sulphur has long been called One of the Four Pillars of Industry. Today's need emphasizes this fact more than ever. Sulphur producers are making every effort to get maximum production from existing mines and to develop new sources of sulphur as quickly as possible.

Texas Gulf Sulphur Co.

75 East 45th Street, New York 17, N. Y.

Mines: Newgulf and Moss Bluff, Texas

In 1945, G. W. E. Nicholson of the Union Bag & Paper Corp. and others in the industry, felt that the mill engineering problems—and there are many and more complex now—could best be handled by a separate division. Thus, the TAPPI Engineering Division was established in 1946 with their first Engineering Conference in October, 1946. The details of the Engineering Division activities are discussed later; here it is sufficient to note that their activities culminate in an annual conference meeting.

Committee Activities

The backbone of the Engineering Division is its committee activity. The following are the main committees, listed only by name to indicate the general scope of the engineering activities:

Chemical Engineering
Data Sheets
Drying and Ventilating
Electrical Engineering
Engineering Research and Machine Design
Hydraulics
Materials Handling
Mill Design and Economic Aspects
Mill Maintenance and Materials
Steam and Power

A committee may have subcommittees for special projects and investigations. A few of these subcommittees and their outstanding work are: Digester Corrosion, and its "Analysis of the Corrosion Questionnaire," and continued analytical work on the subject; Electrical Subcommittees, pertaining to "Machine Constants," "Cable Recommendation," "Analysis of Machine Downtime," etc.; Hydraulic Committee's sponsorship of "Friction of Paper Stock in Pipes" studies at the University of Maine; "Methods for Quickly Estimating Costs of Engineering Projects," etc.

Typical Engineering Conference

Elsewhere in this issue of TAPPI is the program for the coming 8th annual Engineering Conference to be held in Montreal, Oct. 26–29, 1953. This is the Division's first meeting outside of the United States.

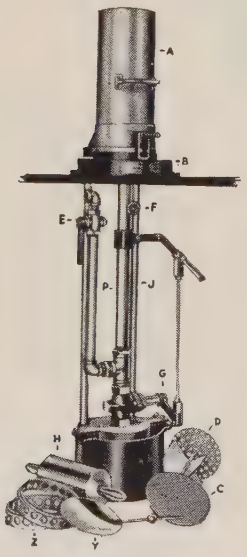
This program shows the range of topics covered and the pattern of a typical conference. Note that there are three *full* days of meetings, 9:00 a.m. to 5:00 p.m., plus one day of plant visits. Also note there are no official social activities while meetings are in session.

The conference meetings are all day Monday through Wednesday, while Thursday is devoted to plant or mill visits. On Tuesday evening is a social and dinner period to promote friendship and the opportunity to become acquainted with others. In keeping with this, the after-dinner speaker is usually a professional entertainer. The official TAPPI luncheon is held on a Wednesday; this is in a serious vein and the speaker's topic is of direct interest to the industry. Registration is $15 to $20, and includes the Tuesday dinner and official luncheon.

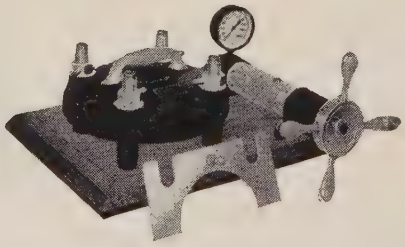
Who Attends Meetings

Our experience has shown that with a good program, carefully selected speakers, and avoidance of social activities during the day, that attendance at meetings is excellent.

The official registration runs from 500 to 700. Our records also show that mill representation will be 40 to 45%. The remainder includes manufacturer's engineers and salesmen,

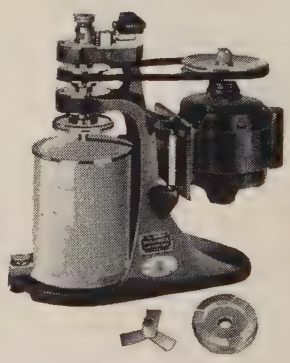


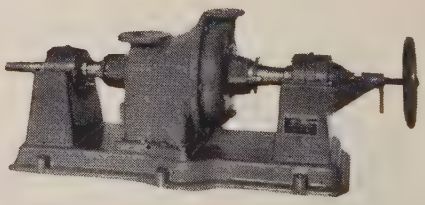
★ SHEET MACHINE
DRYER RINGS
AUXILIARY EQUIPMENT


★ PUMP AND PRESS

★ TAPPI STANDARD

ALSO AVAILABLE:
Fibre Classification Grid
Automatic Couching Device
Automatic Pressing Device
Clark's Kollergang Beater


★ DISINTEGRATOR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LANCASTER, OHIO

consulting engineers, government and press representatives, etc.

Attendance at the committee main session runs 200 to 350, which is excellent considering that every single person attending may not be interested in every topic. Discussion meetings draw 40 to 150 each, with their meetings running simultaneously. Thus, the outstanding over-all attendance is proof of the value of the conference.

How Equipment Manufacturers Contribute to Meetings

We in TAPPI find that the equipment manufacturers—and especially their engineers—contribute a great deal to the over-all success of the meeting. They take their full share of committee activity and program participation.

In addition to their participation in the committee and program activities, equipment manufacturers make another worth-while contribution. By and large, responsible companies send their top-flight engineers to these meetings and are available for consultation. Thus, on most problems, a mill man can find top talent available. Mill people have been quick to recognize the advantages of this arrangement. Many problems are discussed at these informal meetings.

Advantages to Mills

What does one get from three full days of a conference like this? Certainly it's more than just the information in a paper, which can be read in *Tappi*.

Primarily, it is the association and personal discussions and the exchange of information that are so important and mutually helpful. You learn from participation, talking things over with others, finding out what they are doing and how they licked a problem, learning what is new, what the trends are, etc. And knowledge means progress especially important with the rapid growth of technical advances.

There is the trite but true saying that you get out what you put into something. Thus, we encourage mill participation in committee work, special projects, and studies.

The Engineering Division activities continue throughout the year via committees; their work culminates in the annual conference. Every engineer in a pulp, paper, or paper converting plant is welcome to attend the Engineering Conference and to be a member of one of the committees in the Division.

Seventh Alkaline Pulping Conference

The Seventh Alkaline Pulping Conference will be held at the Rice Hotel, Houston, Tex., on Nov. 19–20, 1953. Fred W. Bishop of the Southland Paper Mills, Lufkin, Tex., is chairman of the TAPPI Alkaline Pulping Committee, sponsor of the conference. Ken Running of the Halifax Paper Co., Roanoke Rapids, N. C., is chairman of the Program Committee.

Following is the tentative program.

Tuesday, November 17

4:00–8:00 p.m. Registration (Mezzanine)

Wednesday, November 18

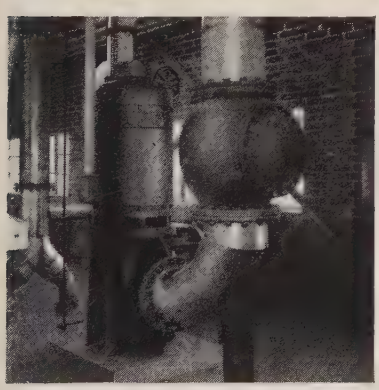
8:30 a.m. Registration

9:30 a.m. Pulp Washing (Crystal Ball Room)

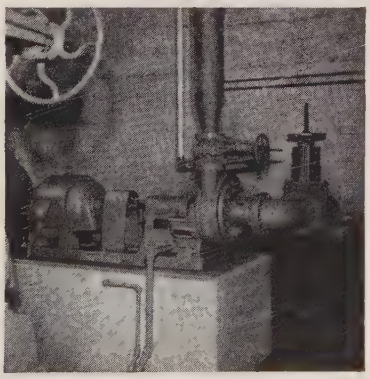
Fred W. Bishop, Southland Paper Mills, Inc., Lufkin, Tex., *Moderator*

1. "Current Report on Pressure Washing," by Lione

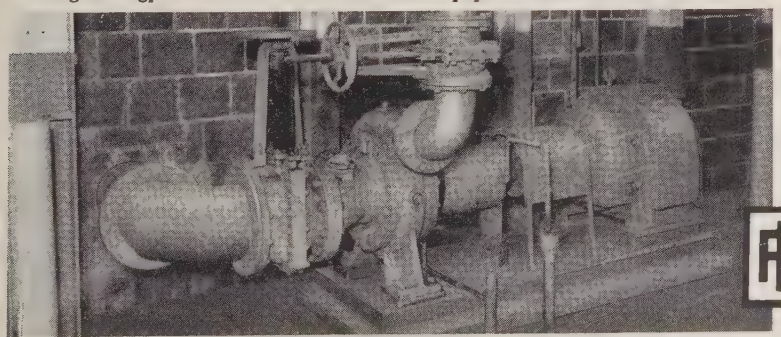
STOCK PUMPS? YES!



A 24 APH single-stage vertical pump used as a fan pump, delivering 8500 gpm.



A 4 FGV stock pump handling 750 gpm of stock from the couch pit of a paper machine.



This 8 HGV pump transfers 3½% stock from a beater dump chest to refiners at a southern mill.

775-10

Ingersoll-Rand's complete line offers an economical solution to every stock pumping problem

From white water to heaviest stock, there's an I-R pump that's specially designed for the job. Available in vertical and horizontal types, they are built to stand up longer under continuous, heavy-duty service. Maintenance, a perennial problem in paper stock pumps, has been reduced and simplified by features like these: large, open suction passages with hand-hole cleanouts—non-clogging impellers—rotors that can be removed without disturbing piping or driver—and interlocked stuffing box glands that are easy to adjust or remove.

The machine feed pump, with feeder propeller and suction take-off for constant delivery is a typical example of I-R special service pump design. Whatever your pump requirements, Ingersoll-Rand has the answer—backed by over 30 years of experience in the paper mill field. For further information, call your nearest I-R branch office.

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M. Sutherland and William S. Mounts, Sutherland Refiner Corp., Trenton, N. J.

2. "Wash Water and Wash Water Heating Systems," by W. C. Chapman, Union Bag & Paper Corp., Savannah, Ga.
3. "Testing of Pulp for Soda Residual," by W. C. Lodge, Pulp and Paper Research Institute of Canada, Montreal, P. Q.

12:30 p.m. Luncheon (Crystal Ball Room)

Speaker: Karl R. Bendetsen, former Undersecretary of Army, presently General Consultant and Assistant Div. Manager (Texas Div.), Champion Paper and Fibre Co., Pasadena, Tex.

2:00 p.m. Pulp Washing and Screening (Crystal Ball Room)

K. D. Running, Halifax Paper Co., Inc., Roanoke Rapids, N. C., *Moderator*

1. "Effect of Digester and Liquor Room Operation on Pulp Washing," by Wilber Orr, St. Regis Paper Co., Pensacola, Fla.
2. "Merits of a 4-Stage Pulp Washer Versus a 3-Stage Pulp Washer," by E. A. Harper, Pulp Mill Superintendent, Hudson Pulp & Paper Corp., Palatka, Fla.
3. "Performance of Cowan Screens on Kraft Pulp," by E. H. Smith, Assistant Technical Director, and W. S. Gardner, Assistant Pulp Mill Superintendent, Crossett Paper Mills, Crossett, Ark.
4. "Flat Screen vs. Ahlfors Screen for Bleachable Pine and Hardwood Sulphate Pulp," by Roy Homans, Development Engineer, and Malcolm Pineo, Technical Director, Brunswick Pulp and Paper Co., Brunswick, Ga.

, 6:00–7:00 p.m. Reception (Crystal Ball Room)

Thursday, November 19

8:30 a.m. Registration (Mezzanine)

9:00 a.m. Pulp Screening (South American Room)

M. B. Pineo, Brunswick Pulp & Paper Co., Brunswick, Ga., *Moderator*

1. "The Use of Centri-Cleaners and Vortraps on Semichemical Pulp," by A. L. Wiley, Technical Director A. E. Stafford, Chemical Engineer, and Russell Adams, Chemical Engineer, Riegel Carolina Corp., Acme, N. C.
2. "Selective Particle Separation by Controlled-Fluid Forces on a Flat Screen," by H. F. Schenk, Magnus Metal Corp., Fitchburg, Mass.
3. "Use of High Intensity Screens in Sulphate Pulping for Coarse Papers," by F. Cooper Ratliff, Gaylord Container Corp., Bogalusa, La.
4. "Use of a Jackson-Church Press in Handling Pulp Mill Rejects," by R. E. Bringman, Chief Chemist, St. Joe Paper Co., Port St. Joe, Fla.
5. Two additional papers will be presented on "Pulp Washing and Screening."

12:30 p.m. Luncheon (where you will)

2:00 p.m. Semichemical Pulping (South American Room)

J. N. McGovern, Forest Products Laboratory, Madison, Wis., *Moderator*

1. "The Influence of Fiberizing Variables in Producing Semichemical Pulp in a Commercial Disk Mill," by Friedrich A. Aflenzer, Forest Products Laboratory, Madison 5, Wis.
2. Two further papers are in the process of being developed.

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3. Panel discussion of the subject.

Friday, November 20

A tour of the Pasadena mill of Champion Paper & Fibre Co. has been scheduled for the morning period with the group being returned to the hotel before lunch. This trip will be available to those desiring to make a Friday departure. Another mill visit is scheduled for Friday to Southland Paper Mills, Inc., at Lufkin, Tex., which is 120 miles north of Houston. Luncheon will be provided for the visitors to Southland. All trips will be made on chartered buses.

On Saturday the University of Houston plays Texas Tech. in Rice Stadium. With a seating capacity of 75,000, tickets probably will be available to the individual at the gate. These two schools are top contenders for admission into the Southwestern Conference and this should be a very hotly contested football game.

A very fine ladies program is being formulated for the period of $2^1/_2$ or 3 days. The program will include a boat trip down the Ship Channel in the Port Commission's well-equipped *Sam Houston*. This is a trip designed to show the fabulous industrial installations of the immediate area. If not in conjunction with the boat trip, a visit will be scheduled otherwise to the San Jacinto Battleground with luncheon at the famous inn and sightseeing from the monument and on the battleship *Texas*. Houston has any number of fine shops and very new, nationally famous department stores. Fashion shows are in progress daily during luncheon at the Sky Terrace of Sakowitz and The Azalea Room of Foley's. Arrangements are in progress to schedule a visit to the Thursday luncheon show of the Smart Shop at the Emerald Room of The Shamrock Hotel.

Second Statistics Conference

Fifty-one individuals attended the Second TAPPI Conference on the Application of Statistical Methods held at Western Michigan College, Kalamazoo, Mich., on June 15–16, 1953. John Langmaid, Jr., of S. D. Warren Co., Cumberland Mills, Me., is chairman of the TAPPI Statistics Committee, sponsor of the conference.

The workshop and lecture sessions were conducted under the direction of Professors Charles Butler and Fred Beeler of Western Michigan College, Professor Goeffrey Beale of the University of Connecticut, Storrs, Conn., and Charles A. Bicking of the U. S. Army Ordnance Corps, Washington, D. C.

The conference was arranged to acquaint the individuals present with the applicability of statistical methods to their problems and to give them a preliminary training so that they may use statistical methods in research, production, and quality control.

Special speakers were present each evening during the period of the conference to discuss pertinent problems in the field as they have found them in their own mills.

Further details about the conference will be published in a later issue of *Tappi*.

Papermaking (Cylinder) Committee

The Papermaking (Cylinder) Committee hold the distinction of being the first Association group to hold a meeting in the new quarters of the Technical Association of the Pulp and Paper Industry at 155 E. 44th St., New York, N. Y.

The meeting held on July 10 was held under the chairmanship of Glen Renegar of the Container Corp. of America, Manayunk, Pa. In attendance also were H. G. Booth and L. R. Ayers of Robert Gair Co., George C. Ehemann, Ohio Boxboard Co., E. F. Manogue, Gibraltar Corrugated Paper

THE SWING IS TO THE NEW

Line pictured at right is producing coated paper at continuous speed of 600 f.p.m. Automatic roll changes effected at both ends of line.

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Accelerates New Bundle, Effects The Splice And Cuts Off Old Web Under Continuous High Speed Push Button Operation

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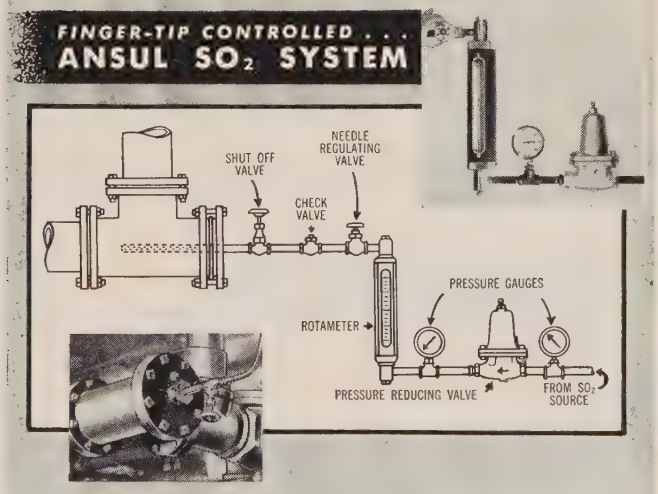

For a small investment you can install an Ansul Finger-Tip Control SO_2 System and be ready . . . *in seconds* . . . to restore your SO_2 concentration.

Ansul Technical Men will willingly cooperate with you. They can help you prepare for hot weather emergencies and ***also show you how to maintain production if your sulfur burner must be shut down.***

Write for file No. 200. You will receive information on how to use Ansul SO_2 to 1) fortify your cooking acid, 2) improve your digester schedules, 3) obtain more complete pulping, 4) get better screening of pulp and, also, 5) for green wood cooks.

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Co., A. E. Bachmann, Missisquoi Corp., and Wm. Czellak, Gardner Board & Carton Co. Bill White and Sam Weber, Black-Clawson Co., E. A. Crawford, Continental Paper Co., and Pete Smith and Tom Luey of the Sutherland Paper Co., Kalamazoo, Mich., and K. M. Winrich, Cornell Paperboard Products Co., Cornell, Wis., were able to be present.

After considerable discussion it was concluded that the committee would collect and correlate factual data in regard to the operation of cylinder board machines and endeavor to stimulate participation in activities by presenting such data in an informal manner.

An informal meeting has been scheduled to be held during the Annual Meeting of the Technical Association, New York, N. Y., Feb. 15–18, 1954.

The following program has been arranged.

Sunday, February 14

In the afternoon a meeting of the committee will be held to correlate programs and to make final arrangements of the sessions.

Tuesday, February 16

"Raw Materials—Pulp Characteristics as Related to Paperboard Products," by A. E. Bachmann, Missisquoi Corp., Sheldon Springs, Vt.

"Odor Problems," by Henry Booth, Robert Gair Co., Uncasville, Conn.

"Stock Preparation (Effect of Wet-End Variables)," by Edwin F. Manogue, Gibraltar Corrugated Paper Co., North Bergen, N. J.

Wednesday, February 17

"Wet-End Operation," by George C. Ehemann, Ohio Boxboard Co., Rittman, Ohio, and W. R. Czellak, Gardner Board & Carton Co., Middletown, Ohio.

"End Use Requirements and Testing," by A. T. Luey, Sutherland Paper Co., Kalamazoo, Mich.

The committee decided to revise TAPPI Committee Project No. 399 on "Caliper and Weight Variation Across the Machine." L. R. Ayers of Robert Gair Co. was appointed chairman of the subcommittee to deal with this project.

The next meeting of the committee will be held in the TAPPI Headquarters at 10:00 a.m., Oct. 2, 1953.

Revision of Pulp Testing Rules

The TAPPI Pulp Testing Committee and the Certified Pulp Testers Bureau have agreed to revise Standard T 210 m-45, Weighing Sampling and Testing Wood Pulp for Moisture to conform to the American Chemical Society's Method for Drying Cellulosic Materials. Accordingly page 15 of the Official Rules approved by the Certified Pulp Testers Bureau (July, 1946) are changed as follows:

"E. Drying of samples: The entire bulk of the samples selected from the bales shall be dried out for the test. After weighing wet samples, these shall be placed in a suitable oven and dried to constant weight. (*Any laboratory drying oven which is capable of maintaining the specified temperatures may be used for drying samples to constant weight.*) *The temperature throughout the oven shall not exceed 108°C. (226.4°F.) at any time during the test and shall be maintained at 105 ± 3°C. (221 ± 5.4°F.) during the last two hours of drying time.* Drying shall be continued until two successive weighings at least three hours apart do not show a variation greater than 0.1 per cent of wet weight of samples, and the minimum weight shall be taken as the final oven-dry weight. The oven shall be equipped with a maximum and minimum thermometer or with an accurate recording thermometer, or with both." (Change from present method is italicized.)

PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

Robert E. Adlard, Managing Director, Evans Adlard & Co. Ltd., Winchcombe, Glos., England.

Richard F. Allen, Chemist, Robert Gair Co., Inc., Uncasville, Conn., a 1949 graduate of Lawrence College.

Alfred W. Arenander, Jr., Purchasing Agent, West Virginia Pulp & Paper Co., New York, N. Y.

Robert G. Arklie, Superintendent of Technical Services, Anglo-Newfoundland Development Co. Ltd., Grand Falls, Nfld. Attended Bishop Field College.

J. P. Auer, President, J. P. Auer, Inc., Mamaroneck, N. Y.

Stanley W. Barrow, General Manager, Empire Paper Mills Co. Ltd., Greenhithe, Kent, England. Attended London University.

Thomas J. Bourne, Jr., Division Manager, Fibre Board Container Corp., Richmond, Va.

Clifton P. Boutelle, Mill Manager, Alliance Paper Mills, Georgetown, Ont., Canada, a 1936 graduate of Carnegie Institute of Technology.

Richard C. Boynton, Vice-President in Charge of Production, New England Container Co., Chicopee, Mass. Attended Norwich University.

Alessandro Brunetti, Assistant General Manager and Director, Societa Agricola Industriale per la Cellulosa Italia, Milano Italy, a 1933 graduate of the Milano Politecnico with an Eng.D. degree.

Vincent A. Carpano, Group Leader, Graphic Arts and Paper, Oxford Paper Co., Rumford, Me., a 1940 graduate of Northeastern University.

Paul E. Curran, Vice-President and General Manager, Wolverine Fabricating & Mfg. Co., Inc., Inkster, Mich., a 1934 graduate of the University of Tennessee.

Arthur L. Davis, Research Manager, Irvington Varnish & Insulator Co., Newark, N. J., a 1939 graduate of Long Island University, with a Ph.D. degree from Brooklyn Polytechnic Institute in 1943.

Donald R. Dick, Labor Relations Manager, Howard Smith Paper Mills Ltd., Cornwall, Ont., Canada.

Albert F. Flash, Works Manager, The Birge Co., Inc., Buffalo, N. Y., a 1948 graduate of Canisius College.

John M. Fulton, President, Pacific Coast Supply Co., Portland, Ore., a 1925 graduate of the University of Nevada.

Robert A. Gloe, Director of Research, Kilborn Photo Paper, Inc., Cedar Rapids, Iowa, a 1941 graduate of Cornell University.

George E. Hall, Jr., Section Head, Wyandotte Chemical Corp., Wyandotte, Mich., a 1940 graduate of Boston University.

Norman I. Howe, Production Superintendent, Dryden Paper Co., Dryden, Ont., Canada.

Eiichi Iketani, Chief of General Affairs Section, Senju Paper Mfg. Co., Ltd., Tokyo, Japan, a 1926 graduate of Keio University.

Ross G. Jones, Chemical Engineer, Kalamazoo Vegetable Parchment Co., Parchment, Kalamazoo, Mich., a 1939 graduate of West Virginia.

Wilbur B. Keller, Chief Inspector, Champion Paper & Fibre Co., Hamilton, Ohio.

J. Vernon Kindall, Research Chemist, Plaskon Div., Libbey-Owens-Ford Glass Co., Toledo, Ohio, a 1948 graduate of Swarthmore College.

Matthew A. Kuclar, Chief Chemist, The Birge Co., Inc., Buffalo, N. Y., a 1953 graduate of the University of Buffalo.

Jon R. Lafrenz, Salesman, Potlatch Forests, Inc., Lewiston, Idaho, a 1949 graduate of the University of Washington.

Charles J. Lahman, Owner, Charles J. Lahman & Associates, Dayton, Ohio a 1939 graduate of the Hays Institute.

Gaston E. Leonard, Technical Director, Societe F. Beghin, Corbehem, P. de C., France.

William N. Lynn, Quality Control Engineer, Western Printing & Lithographing, St. Louis, Mo., a 1950 graduate of the University of Southern California.

Reijo I. Merrikanto, Mill Engineer, Oulu Osakeyhtio, Oulu, Finland, a 1948 graduade of Korkeakoulu Technical College, Helsinki.

Frederick M. Millard, Superintendent, MacMillan & Bloedel Ltd., Pulp Mill Div., Port Alberni, B. C., Canada.

James R. B. Milne, Chief Engineer, Paper Div., Price Brothers & Co. Ltd., Kenogami, P. Q., Canada, a 1924 graduate of H.M. Dockyard, College Rosyth.

Ralph A. Nelson, Chemist, Fox River Paper Corp., Appleton, Wis., a 1942 graduate of Coe College.

Emile Ormann, Chief Editor, Compagnie Francaise d'Editions, Paris, France.

August F. Ottinger, Chief Chemist, Bemis Bro. Bag Co., St. Louis, Mo., a 1941 graduate of Washington University.

Charles E. Peterson, Supervisor, Kraft Paper Div., Central Technical Dept., St. Regis Paper Co., New York, N. Y. Attended the University of Pennsylvania.

G. J. Clement Potter, Technical Information Assistant, Pulp and Paper Research Institute of Canada, Montreal, P. Q., Canada, a 1925 graduate of McGill University.

Patrick S. Quinn, Assistant Mill Manager, Anglo-Canadian Pulp & Paper Mills Ltd., Quebec, P. Q., Canada.

George B. Redmond, Technical Sales-Service, Clinton Foods, Inc., Clinton, Iowa. Attended St. Mary's College.

Charles S. Ruark, Chemical Engineer, Riegel Carolina Corp., Acme, N. C., a 1948 graduate of North Carolina State College.

John R. Schacht, Manager, Paper Chemicals Sales Dept., Rohm & Haas Co., Philadelphia, Pa., a 1934 graduate of Temple University.

Frederick A. Scheer, Laboratory Engineer, Ford Motor Co., Dearborn, Mich., a 1938 graduate of Washington University, St. Louis, Mo.

John C. Simonich, Resident Manager, Kimberly Clark Corp., Niagara Falls, N. Y., a 1918 graduate of the Stout Institute.

Ronald S. Smith, Chemist, New York & Pennsylvania Co., Inc., Castanea Mill, Lock Haven Pa., a 1950 graduate of Pennsylvania State College.

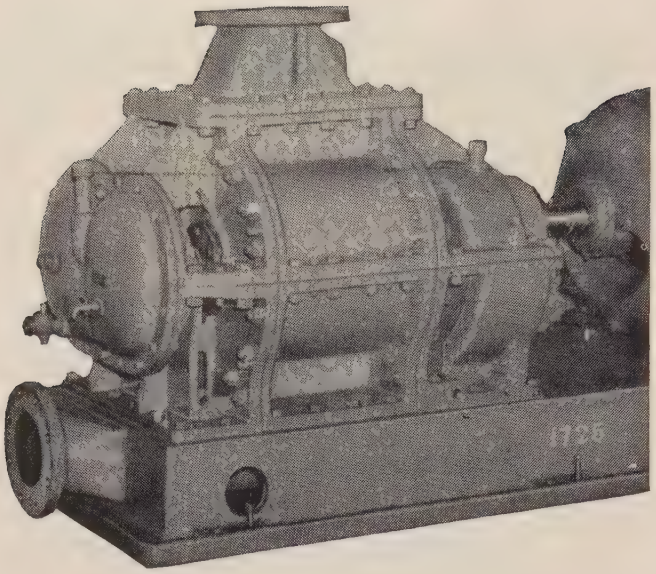
Richard M. Stewart, Manager, Quality Control and Inspection Dept., Cincinnati Industries, Inc., Lockland, Ohio.

S. Sugeta, Chief, Research Section, Toho Rayon Co. Ltd., Tokyo, Japan, a 1936 graduate of Tottori Agricultural College.

James G. Sylvester, Supervising Research Engineer, Mutual Boiler & Machinery Insurance Co., Boston, Mass., a 1942 graduate of U. S. Merchant Marine Academy.

Anthony E. Thiesen, Secretary and Purchasing Agent, Chemipulp Process, Inc., Watertown, N. Y., a 1942 graduate of Oregon State College.

Bert E. Tripp, Jr., Chemist, Azon Corp., Binghamton, N. Y., a 1947 graduate of Syracuse University.



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Karel J. J. Van der Grinten, Director of Factory, Chemische Fabriek L. Van der Grinten N.V., Venlo, The Netherlands, a 1924 graduate of the University of Zurich with a Ph.D. degree.

Edward P. Walsh, Groundwood Engineer, Anglo-Canadian Pulp & Paper Mills Co. Ltd., Quebec City, P. Q., Canada, a 1946 graduate of McGill University.

Gordon F. Warner, Chief Chemist, Illinois Shade Cloth Corp., Chicago Heights, Ill., a 1947 graduate of the State University of Iowa.

Eugene W. Weith, Technical Service, The Glidden Co., Cleveland, Ohio. Attended the Case Institute of Technology.

Rex J. Wells, Mill Manager, Kimberly-Clark Corp., Niagara, Wis., a 1922 graduate of the University of Michigan.

Fritz M. K. Werdouschegg, Pulp and Paper Chemist, Case Brothers, Inc., Manchester, Conn. Attended the Karl Franzens University in Graz, Austria.

Forrest H. Werling, Mill Manager, Kimberly-Clark Corp., Neenah, Wis., a 1927 graduate of Cornell College, Iowa.

Alfred D. Wilkinson, Mill Manager, Kimberly-Clark Corp., Kimberly, Wis., a 1928 graduate of Cornell College.

TAPPI Notes

Lawrence R. Adkina, formerly of the Pond's Extract Co., is now Chemist for the Waterfalls Tissue Corp., Mechanic Falls, Me.

John Ainsworth, formerly of the Central Paper Co., is now Supervisor of the pulp mill laboratory, Thilmany Pulp & Paper Co., Kaukauna, Wis.

Edward J. Albert, President of the Thwing-Albert Instrument Co., Philadelphia, Pa., was elected President of the Scientific Apparatus Makers Association at its annual meeting held recently at White Sulphur Springs, W. Va.

Betty S. Allender, formerly of Carolina Paper Mills, Inc., is now Technical Director of Papelos Venezuelanos, Caracas, Venezuela.

Ellis T. Anderson, formerly of the Fulton Bag & Cotton Mills, is now Plant Manager of Arkell & Smiths, Inc., Wellsburg. W. Va.

Paul C. Baldwin is now Vice-President in Charge of the West Coast Operations of the Scott Paper Co., Everett, Wash.

Wilmer J. Balster is now President of Don L. Quinn Co., Chicago, Ill.

Robert C. Brown is now Group Leader for Coating at the Oxford Paper Co., Rumford, Me.

Wentworth Brown, formerly of the Brown Corp., is now Vice-President and General Manager of Columbia Cellulose Ltd. and Celgar Development Ltd., Vancouver, B. C.

John B. Calkin, formerly of the University of Maine, is now Assistant to the President and Director of Market Research for Foster D. Snell, Inc., New York, N. Y.

W. Boyd Campbell, formerly of the Pulp and Paper Research Institute of Canada, has retired and is now a Consultant at 4217 Kensington Ave., Montreal, Que.

E. A. Charlton, formerly of the Central Paper Co., is now a Consulting Engineer in Muskegon, Mich.

George S. Douglas is now Manager of Manufacturing at the Escanaba Paper Co. Div., Mead Corp., Escanaba, Mich.

James G. Dunlap, formerly student at the Western Michigan College, is now in the U. S. Army.

Paul S. Fensom is now Director of Purchases for the St. Joe Paper Co., Port St. Joe, Fla.

Jeanne H. Fisher, formerly of the Glassine Paper Co., is now Research Chemist in the Product Development Dept. of the Paterson Parchment Paper Co., Bristol, Pa.

Kristian Fougner, formerly of A/S Borregaard Co., is now Sales Engineer for A/S G. Hartmann, Oslo, Norway.

O. P. Gephart, formerly of A. M. Meincke & Sons, Inc., is now President of Patexol Products, Syracuse, Ind.

Victor M. Granada, formerly student of New York State

College of Forestry, is now Research Chemist for the Rhinelander Paper Co., Rhinelander, Wis.

Arthur J. Haug has been transferred from Chester, Pa., to Everett, Wash., where he is Production Manager for the Scott Paper Co.

William R. Haselton, Technical Director of the Rhinlander Paper Co., Rhinelander, Wis., was awarded the Westbrook Steele gold medal for his outstanding doctoral thesis.

Robert B. Hobbs is now Chief of the Paper Section of the National Bureau of Standards, Washington, D. C.

Frank J. Hoffman has been appointed Product Development Specialist, Converted Products, in the Sales Div. Product Development Dept. of the Sorg Paper Co., Middletown, Ohio.

Edward J. Howard is now Manager of Pulp Research and Development of Industrial Cellulose Research Ltd., Hawkesbury, Ont.

William J. Johnson, formerly of Heaps, Waterous Ltd., is now Western Sales Engineer for Canadian Vickers Ltd., Vancouver, B. C.

Arthur E. Jones is now Administrative Assistant Director of Research for the Oxford Paper Co., Rumford, Me.

W. A. Kirkpatrick is now Vice-President of The Allied Paper Mills, Kalamazoo, Mich.

Paavo Kiwi is now General Technical Director of the mills of Kajaani O/Y Kajaani, Finland.

James R. Lyons, formerly of the F. G. Findley Co., is now in the Research and Development Dept. of Atlas Boxmakers, Inc., Chicago, Ill.

George S. McKnight is now Assistant Director of Research of the Oxford Paper Co., Rumford, Me.

Paul J. McLaughlin, formerly of the Hercules Powder Co., is now with Rohm & Haas Co., Philadelphia, Pa.

Robert S. Magruder, formerly of the Paper Corp. of America, is now Sales Engineer in the Pulp and Paper Div. of Sprout, Waldron & Co., Inc., Muncy, Pa.

Bernard K. Mayer is now Group Leader for Pulping for the Oxford Paper Co., Rumford, Me.

Oscar L. Miller, formerly of APW Products, Inc., is now Manager of the Bloomfield Paper Mill, Marcalus Mfg. Co., Bloomfield, N. J.

James A. Mitchell is now Manager of The Cellophane Technical Section, Spruance Cellophane Plant, E. I. du Pont de Nemours & Co., Inc., Richmond, Va.

Robert A. Negaard, formerly of the Continental Can Co., is now Technical Sales and Service Representative, Kraft Paper & Board Div., St. Regis Sales Corp., New York, N. Y.

Richard E. Pentoney, formerly Graduate Student, is now Instructor in Wood Technology at the College of Forestry, State University of New York, Syracuse, N. Y.

Eric S. Prior, formerly of The Oxford Paper Co., is now Treasurer and Controller of the H. P. Smith Paper Co., Chicago, Ill.

Warren R. Purcell, formerly of The Brown Co., is now Industrial Consultant for Rath & Strong, Boston, Mass.

William F. Scanlan, formerly of the Swenson Evaporator Co., is now a Manufacturers Representative and Sales Chemical Engineer, Camden, N. J.

Joseph J. Schwenkler is now Assistant Technical Superintendent of the Container Corp. of America, Manayunk, Pa.

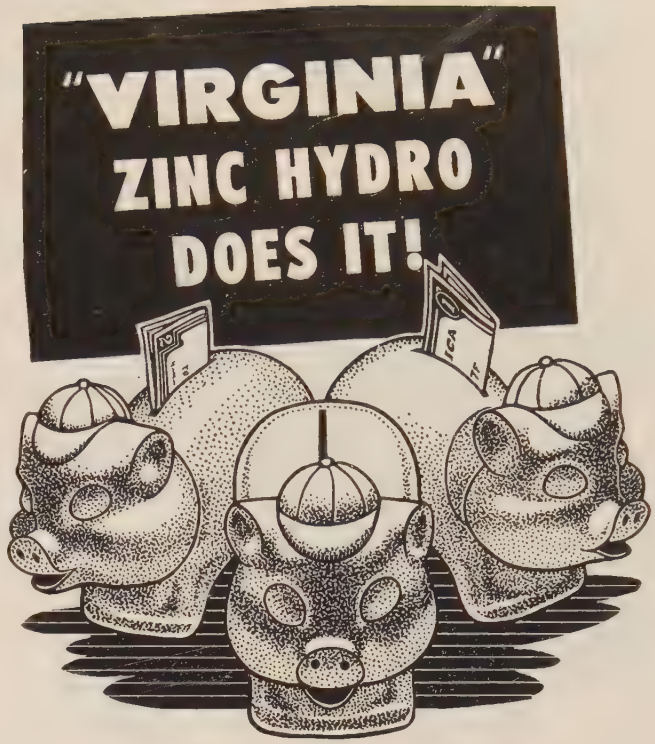
David E. Shotwell, Sales Representative of the Printing Ink Div., Interchemical Corp., has been transferred from Cleveland to Cincinnati, Ohio.

Gordon A. Sutton, formerly of the Lake St. John Power & Paper Co., is now Assistant Manager of the Abitibi Power & Paper Co., Ltd., Thunder Bay Div., Port Arthur, Ont.

Austin H. Tifft is now Group Leader for Chemical Engineering at The Oxford Paper Co., Rumford, Me.

Linwood G. Willens of the Pulp Div., Weyerhaeuser Timber Co., has been transferred from Longview to Everett, Wash.

Leonard J. Wood, Jr., Technical Supervisor, Paper Techni-



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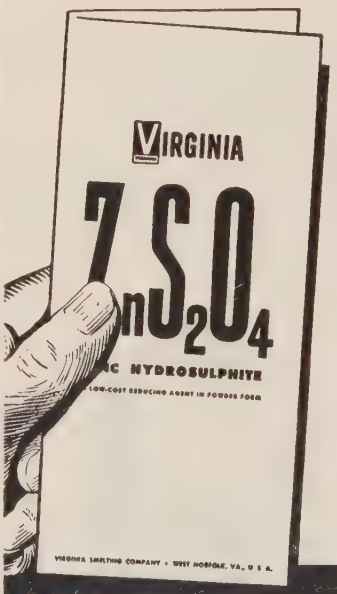

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cal Service for the National Starch Products Co., has been transferred from New York City to Boston, Mass.

Note: Members of the Technical Association are urged to advise the Association Secretary of any changes in position or address. Please check the 1953 *TAPPI Year Book*.

Letters to the Technical Association of the Pulp and Paper Industry and *Tappi* should be sent to the *new address*, 155 E. 44th St., New York 17, N. Y.

Industry Notes

Production

In May the paper industry maintained production at near record level at 2,272,000 tons, comprising 1,090,500 tons of paper, including newsprint and building papers and 1,181,500 tons of paperboard. For the first 5 months of the year, the production of 11,086,061 tons is 8.6% higher than for the same period in 1952 and 3.1% lower than in 1951.

The printing paper branch of the industry continued to show the greatest relative strength by producing a record-breaking 1.5 million tons of paper during the first 5 months of 1953.

Wood Pulp

April production of wood pulp was 1,478,000 tons, the third highest on record. For the first 4 months of the year 5,796,000 tons were produced, an increase of 2% over the comparable months of 1952.

Wastepaper

Wastepaper receipts in April of 763,000 tons were 17% above receipts in April, 1952. For the first 4 months receipts amounted to 2,839,000 tons, about 10% above the receipts of the first 4 months of 1952.

Going into the second half of 1953 wastepaper consumption in the United States approached in volume the record-breaking consumption of the first half of 1951. It is estimated that during the first half of 1953 the paperboard mills, the paper mills, the building materials mills, and the wet machine board mills consumed 4,325,000 tons of wastepaper divided as follows: paperboard—3,350,000 tons; paper—570,000 tons; building materials—360,000 tons; and wet machine board mills—45,000 tons.

The following tabulation shows the record of mill receipts and consumption for the first 6 months of the past 9 years:

Year	*Receipts*	*Consumption*
1945	3,532,000	3,515,000
1946	3,683,000	3,576,000
1947	3,971,000	3,989,000
1948	3,921,000	3,965,000
1949	3,022,000	3,121,000
1950	3,661,000	3,692,000
1951	5,158,000	5,076,000
1952	3,770,000	3,805,000
1953	4,290,000	4,325,000

Wastepaper Marking Code

The Fibre Box Association and the National Paperboard Association have adopted a code for marking containers which contain materials difficult or impossible for reuse by the wastepaper consuming segment of the paperboard industry.

In this code A indicates the presence of asphalt; P indicates polyethylene and S indicates the presence of sulphur. These insignia are to appear on one top flap and one bottom flap. These markings are shown as follows:

Southland

Thirteen years after producing its first paper, Southland Paper Mills, Inc., Lufkin, Tex., rolled off its one-millionth ton of newsprint on March 20, 1953.

Tree Farms

More than 2,800,000 acres of crop-producing, tax-paying forest lands were added to the American Tree Farm System during the past 12 months. At present there are 28,170,320 acres of tree farms in the United States.

International Exhibition

The Fourth International Paper and Allied Trades Equipment Exposition will be held in the Grand Palace, Paris,

General view of the last International Exposition

France, in May, 1954. The exhibit will be limited to paper, paperboard, and printing machinery.

Air Handling

The Refrigeration and Air Conditioning Exposition will be held in Cleveland on Nov. 9–12, 1953. It is under the direction of Banner & Greif, 250 W. 57th St., New York 19, N. Y.

Norman Alper

Norman Alper & Co. has been established at 111 India St., Pawtucket, R. I., to engage in papermakers' supplies, fibers, and chemicals. Mr. Alper has long been associated with the wastepaper industry.

Drupa

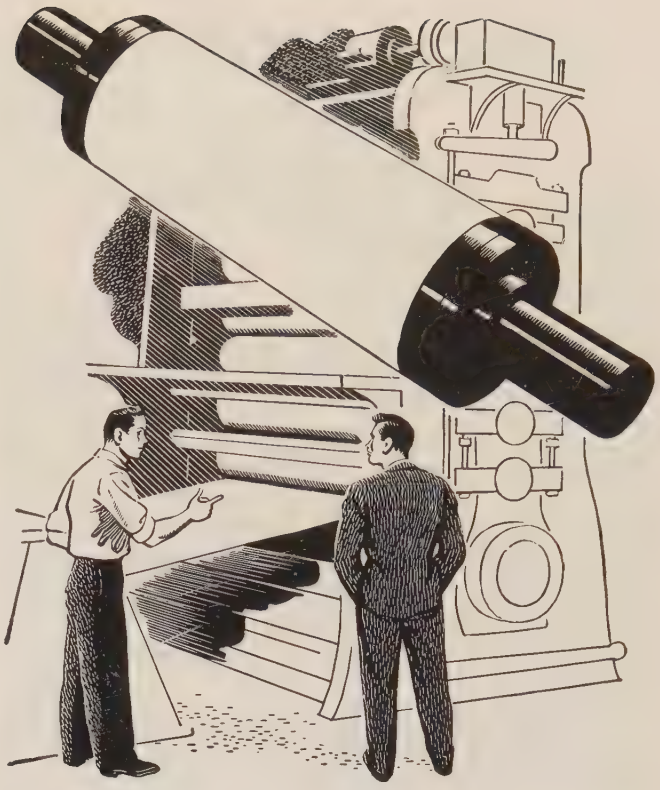
The Drupa International Fair for Print and Paper will be held at Dusseldorf, Germany, on May 15–30, 1954. It will exhibit machinery, paper, and paper converting, graphic arts products, etc.

Newsprint Transportation

The U. S. Dept. of Commerce, Washington, D. C., has issued a 126-page book on "Transportation Factors in the Marketing of Newsprint." Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., at 40¢ per copy.

Trees to News

McClelland & Stewart Ltd., Toronto, Ont., has published



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an extremely interesting 364-page book by Carl Wiegman, entitled, "Trees to News," a chronicle of the Ontario Paper Co.'s origin and development. Included is the story of Baie Comeau.

Ohio Boxboard

Dudley W. Maxon of Akron, Ohio, has been elected executive vice-president of the Ohio Boxboard Co., Rittman, Ohio. He has been legal adviser to the company since 1933.

Lowell Textile

The name of the Lowell Textile Institute, Lowell, Mass., has been changed to Lowell Technological Institute of Massachusetts.

Finland

Owing to its unfavorable situation as regards to costs, the Finnish industry has felt compelled to restrict its production, which is normally about 1,150,000 tons of market per annum, or not quite 100,000 tons a month. We are given to understand this reduction amounted to 100,000 tons already in the first quarter of this year, and probably to as much in the second quarter. The question of how trade and industry in Finland, and more particularly the wood-processing industries of that country, will be able to adapt their costs and incomes to the international values, is at this moment one of great urgency, but in the present political situation in Finland, no definite solution seems to be available.

Sweden

The troubles of the Swedish pulp and paper industries are by far not overcome as yet, but since the difference between the United States price level and the world market prices now has been equalized and a balance of supply and demand seems near, it will be reasonable to assume that stability of prices has now been reached. There remains, however, the fact that the current prices are unsatisfactory in comparison with the production costs of the Swedish industry; an adjustment in this respect will be unavoidable in the long run and will probably have to be reached by a reduction of costs and not in the first instance by an elevation of the price level.

Holland

A large paper manufacturer in Holland is reported to have successfully used straw pulp in the making of tablet writing, bank paper, and tissue for carbon copies. Reports indicate that about 70% straw pulp was used in the manufacture of tablet, about 60% on the bank paper, and between 30 and 50% in the tissue for carbon copies.

China

The following article on current developments in the paper industry in China was written by John Cardew and appeared in *The World's Paper Trade Review* of April 9.

An announcement by Peking radio that the big state-owned Kwangtung paper mill in Canton, south China, is being reconstructed to make it one of the largest in China for the production of newsprint and pulp, is the latest indication of the high priority being accorded to paper output under present Chinese plans for the development of light industry. China's production of paper has been rising steadily since the end of the civil war on the mainland in 1949, and last year more than doubled the prewar record. A further increase is being aimed at this year, and in the main it is to be achieved by reorganizing and extending existing mills.

However, although new plants are not planned on anything like the same scale as in the case of heavy industry, a good deal of equipment of all kinds will be required to secure maximum output from mills previously neglected or damaged during the civil war. Thus new machines being installed in the Kwang-

tung mill include big wood grinders, Kamyr-type pulping machines, and other units. In addition, the fuel supply system is to be completely mechanized.

Construction of the mill started before the Anti-Japanese War, but only part of it had been completed by 1949. Restoration work began immediately and partial operation began soon after. Plant premises to be erected in the course of this year will cover over 17,000 sq. yd. of floor space, which is double the amount rebuilt during the past 3 years. Also included in this year's program are workers' living quarters, a school and hospital, and other amenities.

Apart from the extensive use of bamboo for pulp making, a number of other recent developments have been contributing to the growth of the Chinese industry. Pulp is also now being successfully made from sugar cane stalks by a mill in the important sugar-producing province of Szechuan. A Soviet method is being used, and production has begun under the direction of a Soviet expert. In the past sugar cane stalks were either discarded or used as fuel after the extraction of the sugar content. Paper made from the pulp is said to be suitable both for writing and wrapping purposes.

Greater use of coal instead of wood for domestic fuel is also making available more timber for papermaking. A typical example of this trend is in Szechuan Province, where the key Chengtu-Chungking railway was completed last year. The new railway passes through a region where coal reserves are estimated at over 400 million tons, but in the past, owing to the lack of modern transport, the price of coal increased fivefold by the time it reached Chengtu, and the population was forced to use firewood as cooking and heating fuel. Now that coal can be carried for less than one third of the former cost, it is replacing wood as a fuel in Chengtu, with the result that an estimated 200,000 cu. m. of timber will be saved annually —"an amount," to quote one Chinese writer, "which could be used to turn out 40,000 tons of paper."

Improved lumbering methods in Chinese forests are also making more timber available for the paper industry, in spite of the greatly increased demands of construction. The present practice of felling trees at a stump height of 20 cm. instead of the former 70 cm. together with the utilization of top logs up to 6 cm. in diameter and various rationalization schemes, is reportedly resulting in an annual saving of more than 700,000 cu. m. of timber. In due course the numerous huge reforestation schemes under way in China—the long-term aim is to change the country's present topography from 5% of forest area to 20%—will also make possible a considerable expansion of the paper industry. Altogether China has an area 11 times the size of the British Isles suitable for forest production, and it has recently been established that timber reserves in several leading producing regions are much greater than was previously thought. The Ichun forest in Sungkiang Province, Manchuria, for instance, is now said to have reserves amounting at least to over 35,000 million cu. ft., compared with the Japanese estimate of over 700 million cu. ft.

Meanwhile, the importance of bamboo as a raw material for the paper industry is growing. Shanghai mills using bamboo pulp are now turning out high quality paper, which was prominent among products of light industry displayed at an exhibition held in the east China city early this year. In Fukien Province, too, the widespread cultivation of bamboo has led to a big increase in the supply of pulp for papermaking. No fewer than 80% of the counties in the province are engaged in the industry. Bamboo produces paper of three grades, the first being white and of good quality which makes it suitable for printing and writing. The second grade is newsprint and the third is yellowish in color and of uneven thickness. Over 300 mills are operating in Fukien and production is approaching the prewar record level, which was about 44,000 tons. At one time only 46 of the province's 330 mills were operating and 5000 paper workers were unemployed. Fukien paper is much in demand at the present

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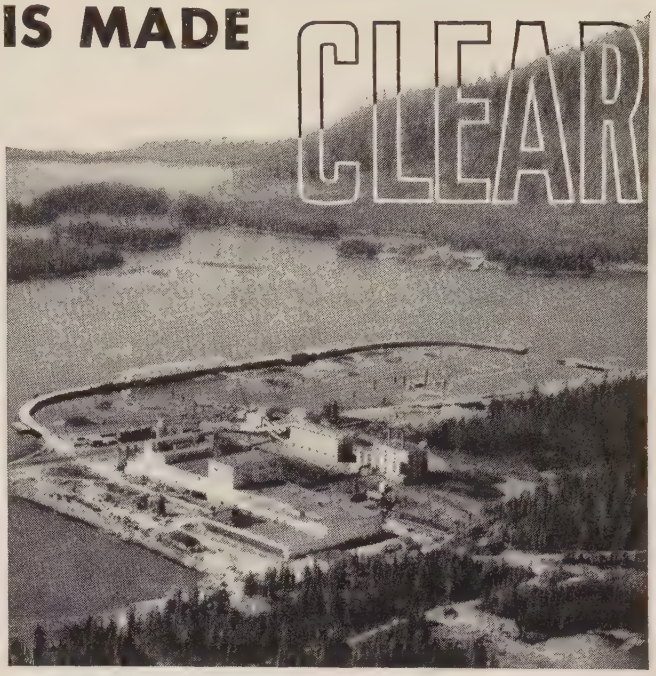

Photo by Robert Yarnall Richie

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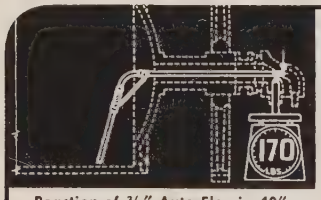

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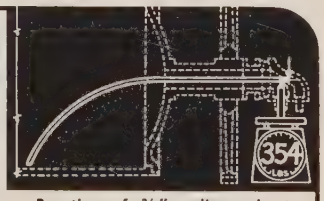

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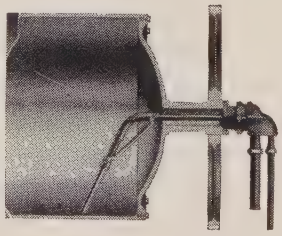

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time and is selling as far away as Kunming in the southwest, remote Sinkiang, and Manchuria.

Taking the highest prewar paper production in China as 100, output in 1949 was 90 and last year 234. Compared with 1951, the increase last year was just over 50%. The target set for the current year is a further rise of 6%. Some idea of the rapidly rising consumption of paper in China can be gained from the increased sales recorded in 1952 by state commercial enterprises. These totaled 157,998 tons, or some 50,000 tons more than in the previous year. In Manchuria, where rehabilitation of the industry was carried out much earlier than in other parts of the country, output has increased at a rapid rate, more than doubling in 1950, to reach a figure of some 50,000 tons. Last November, paper mills in Manchuria were reported to have fulfilled their 1952 production targets.

With 70% of Chinese light industry still in private hands, privately owned paper mills are accounting for an important share of production. In east China, main center of light industry in the country, there are many small units, and on the basis of government-guaranteed supplies of raw materials and, frequently, purchases of output, all have been working at full capacity for some time. Another type of mill is that jointly owned by private enterprise and the city or town authority. One of the best known of these is the Tienfong Paper Mill in Shanghai, which produces about 10 tons of newsprint daily.

Because of a constant and enormously growing demand, however, it will be some time before China's own production of paper can meet all home needs. Whether it is the preparation of blueprints for large-scale construction programs under the first 5-year plan, or the spread of literacy to millions of peasants, virtually every development now taking place in China means an unprecedented demand for paper. Cultural and educational requirements alone are tremendous. Something like 80 million copies of books and magazines were printed last year, and in December it was reported that over 300 Soviet textbooks alone were being translated for publication. A new publishing house has also now been set up in Peking to issue a wide variety of Chinese and foreign books in the languages of China's numerous national minorities. In addition, there are, at the present time, more than 750 newspapers in the country, with a constantly growing circulation which has so far reached 8,000,000. It is not surprising, therefore, that China is having to import paper—from her Eastern trading partners, especially the Soviet Union and Poland—and has indicated an interest in newsprint and bank and magazine paper from Britain. Western Germany is currently exporting paper to China as part of the 37,500,000 United States dollar agreement concluded with the Chinese last Summer by West German businessmen who attended the Moscow Economic Conference, but further imports from the West are needed to supplement Eastern supplies and China's own production. In due course China herself will, undoubtedly, become an exporter of certain types of paper, and in this connection it is interesting to note her undertaking to send 10,000 tons of newsprint to Ceylon under the 1-year trading agreement concluded between the two countries toward the end of last year.

China is also beginning to make an increasing amount of the machines and equipment needed for her paper mills. A modern mill established last year in Kiangsi Province—noted also for its handicraft paper manufactures—was equipped entirely with machinery made in Shanghai. In a recent report on China's 1953 Budget, the Minister of Finance said that while some of the equipment that would be needed for new construction could be ordered from abroad, "we must depend largely on the production of existing industrial enterprises." To this end a nationwide campaign has been launched to ensure that every enterprise is utilized to the maximum possible with present equipment. Paper mills have already done a good deal in this direction, and the direc-

tor of a Mukden mill was recently rewarded for improving the efficiency of old installations in his plant.

Soviet and East European industry can be expected to receive many of the orders to be placed abroad for papermaking and other machinery, but Chinese spokesmen have made it clear that there is also keen interest in obtaining a wide variety of engineering imports from Western countries.

Latin America

A dispatch from Petropolis, Brazil, which appeared in the New York *Herald Tribune* of May 24, stated that Latin-America's vast forests may some day help solve the world's newsprint shortage.

But before that goal can be achieved, the continent's pulp and paper industry will have to undergo a $700,000,000 expansion program.

That's the gist of a report made public by the Economic Commission for Latin America which has completed an extensive survey of the region's pulp and paper resources.

"Latin-American in general and most of the individual countries, have sufficient fibrous resources not only to meet their domestic requirements but also to contribute, through exports, to the reduction of the world shortage of paper and raw materials for paper," the commission found.

The pine forests of Latin America alone are capable of meeting the entire needs of the region although they cover only 5% of its total forest area, the survey says.

Besides the pine woods there are tropical and semitropical forests of hard woods, huge supplies of wheat straw and sugar cane bagasse—a waste product of the sugar cane mill. All of these can be used in making paper.

The Latin-American commission agrees with other analysts who have warned that the world shortage of newsprint, paperboard, and other pulp and paper products is becoming more serious. It cites figures compiled by the United Nations Food and Agriculture Organization pointing to a probable world demand of 49,000,000 tons of pulp by 1960—excluding the Latin-American nations. That would be an increase of 19,000,000 tons over current pulp consumption.

Joint production of Canada, the United States, and Europe will fall short of the 1960 demand, the commission believes. But, it says, Latin America could develop a surplus supply that would make up the difference.

At present the Latin-American paper industry comprises 190 mills, most of them located in Argentina, Brazil, Chile, and Mexico. They produce 989,000 tons of paper and paperboard a year, including 48,000 tons of newsprint. This supplies only a small part of the area's present needs.

The commission report envisions an expansion program that would include the building of more than 50 "large" pulp and paper mills during the next 12 years. Output of fibrous material would be increased to 8,500,000 tons annually. This would meet Latin-America's anticipated requirements and leave a surplus of 1,500,000 tons available for export.

This construction program would cost an estimated $700,000,000. But that's not all. Many other new facilities would be needed.

Latin-American electric power capacity would have to be increased by about 3,500,000 kw. Additional fuel supplies equivalent to 160,000 tons of coal a year would have to be provided. The expanded pulp and paper industry would also consume 140,000 additional tons of sodium chloride annually and 110,000 tons of lime.

It would also be necessary, the survey points out, to insure an abundant water supply for the industry and to build many miles of new highway and rail facilities, not only to obtain access to the forests but also to transport finished products.

A program of such magnitude, the commission says, had best be undertaken jointly by entire groups of nations rather than by individual countries going it alone.

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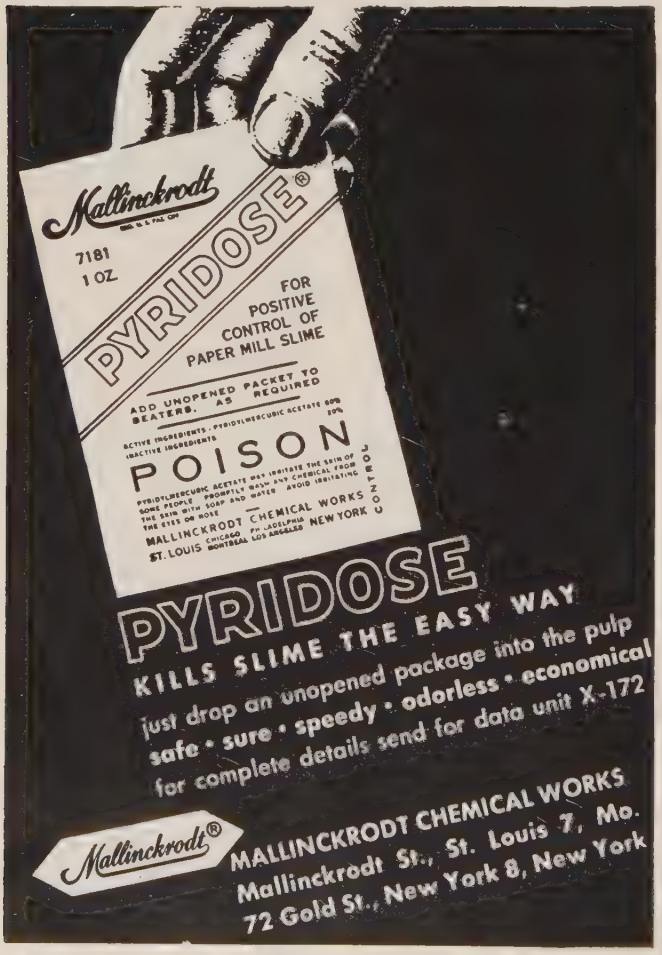
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New Zealand

The consultants of the Tasman Pulp and Paper Co., Ltd., are now designing a plant which initially will produce 75,000 tons of newsprint on one three-roll machine, 150 tons of pulp per day, and 72,000,000 board feet of lumber working the sawmill two shifts a day.

The site for this plant has been finally changed from Murupara, 40 miles up the Rangitaiki River, to Kawerau only a few miles up the Tarawere River, which will simplify the water pollution problem. This site will also probably give access to geothermal steam, but reliance is not being placed on this until the second stage of the mill's development when a second three-roll newsprint machine will come into operation.

The sawmill will be the first unit to start in September, 1954, so that the logging organization can gradually work up to the full log supply required when the pulp mill opens.

Joint U. S.-Japanese Pulp Co.

Unconfirmed press reports from Tokyo state that a preparatory committee for setting up a concern to develop Alaskan forest resources is said to be making definite headway. According to a plan for a new firm, it would be capitalized at $4,000,000 and called the Alaskan Pulp Co. The projected company would be set up parallel to an American corporation to be called the Sitka Lumber and Pulp Co., with a capitalization of about $15,000,000. The United States company would borrow $30,000,000 from the U. S. Export-Import Bank as funds. The Alaskan Pulp Co. would invest in the Sitka Lumber and Pulp Co. and act as the sole agency for the latter for all sales to Japan. In the first year, the company would build a lumber mill costing $2,500,000 and ship half the produced lumber and all the lumber chips to Japan. In the second year, the company would construct on a 3-year plan, a pulp mill with a 100,000-ton capacity, half rayon, half paper pulp production. The mill is expected to reach full operations by the fifth year, with the entire output to be shipped to Japan.

Checking on this report by the APPA the Washington office has advised that after contacting the Japanese Embassy, the State Department, and the Forest Service, nothing definite could be ascertained as to the above-proposed Japanese-U. S. pulp company in Alaska. Apparently the recent meeting held in Japan of all the business people in the pulp, rayon, newsprint, and lumber industries "did not definitely determine the future action of this group as regards to what they will ultimately do in Alaska."

Philippines

Messrs. Hisey and Hayes of the Sandy Hill Iron & Brass Works, Hudson Falls, N. Y., were recently commissioned to undertake a study in the Philippines of the forest growths, possible paper mill sites, and other problems contingent on such a vast undertaking. Between 6 and 8 weeks were spent tramping the forest trails on the Island of Mindanao, and studying all available records. They investigated the availability of materials and labor and a hundred and one other problems.

Hundreds of pages of findings were tabulated upon their return. Pictures were cataloged, engineering details worked out, and preliminary marketing figures were established.

One vital question remained to be answered, "Would the native hardwoods of Mindanao make good paper?" No mill existed in all the islands to produce this answer. And so, trees were cut and a quantity of logs were loaded into a ship and carried halfway around the world to New York harbor where they were loaded onto box cars for transfer to Hudson Falls.

The wood arrived at Sandy Hill in early April—an odd-looking lot from trees with queer sounding names like White Lauan, Gubas, Anabiong, Ilang-Ilang, and Tolo. The logs

were barked here on one of the Peppy Peelers. Then began the processes that would transform them into newsprint.

Four near-by paper mills lent their good help and the barked logs were transported to these cooperating mills: The International Paper Co. at Ticonderoga; Ancram Paper Mills at Ancram; Imperial Paper and Color Corp. at Plattsburg, and the Newton Falls Paper Co. at Newton Falls.

Some of the finished newsprint was tried out on the presses of the Glens Falls Post Co. for a special edition of the Glens Falls *Times*. It was found to be of high quality and equal to that manufactured from our native woods.

In late May, 18 tons of this, the first commercial newsprint ever to be produced from native hardwoods of the Philippine Islands, left San Francisco bound for Manila. This is enough to print one edition of each daily and weekly newspaper on the islands and this edition will be printed on the Fourth of July also celebrated as Independence Day in the Philippines, now a 7-year-old republic.

One phase of the project is now completed—one chapter of the story has been closed. The next chapter may reveal the design and construction of a complete pulp and paper mill. If this happens, the Philippine Islands will have a new industry—the commercial production of newsprint.

Loblolly and Shortleaf

Guides for deciding when to cut loblolly and shortleaf pine saw-timber trees have been issued as Occasional Paper 129 of the Southern Forest Experiment Station, U. S. Forest Service. The authors are Sam Guttenberg and R. R. Reynolds.

The paper, titled "Cutting Financially Mature Loblolly and Shortleaf Pine" deals specifically with the pine forests of northern Louisiana and southern Arkansas, but the authors say that the findings should apply on good sites throughout the range of loblolly. The data are not adapted to pure shortleaf pine stands.

According to the paper, a tree should be cut when it is financially mature—that is, when its rate of earning from improvement in size and grade falls below the rate desired by the timber owner. To determine the size at which pines reach this point of financial maturity, Guttenberg and Reynolds have calculated net lumber values for trees of the various diameters and grades, and have estimated the rate of increase in value that can be expected if trees of different vigor classes are left to grow 5 more years.

The paper concludes with some simple marking guides that can be used in the woods. These guides show that where the owner is satisfied with a 4% return from his trees, he can grow high-vigor pines to 21 in. or more in diameter. If a 3% return is sufficient, the trees can be kept until they are at least 25 in. in diameter.

Copies of the paper are available at the Southern Forest Experiment Station, 704 Lowich Building, New Orleans 13, La.

West Virginia

One of the last of a series of major projects of a long-range modernization program which has created an almost entirely new pulp and paper mill in Covington since the end of World War II had reached final completion July 8 as West Virginia Pulp and Paper Co. placed a new paper machine in operation.

Installation of the new papermaking equipment culminated 3 years of planning and a 1-year construction job, which was completed 9 days ahead of schedule.

Designated as No. 8, the machine represents the latest in papermaking equipment and is designed to manufacture products of the highest quality by low-cost methods which should help to improve the competitive position of the local plant.

Installation of the new machine is the latest phase of a broad modernization program which has resulted in the mechanization of the plant's woodyards, the rebuilding and

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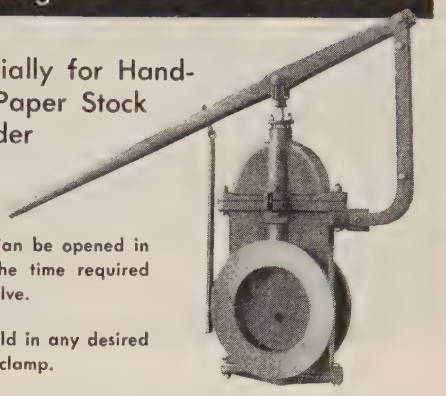

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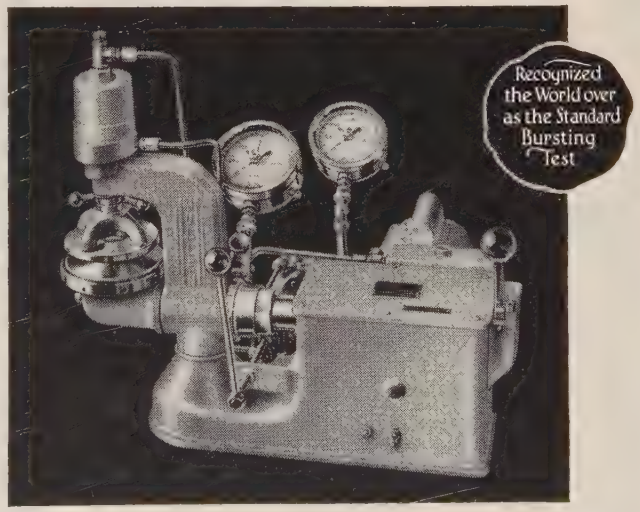

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Wet end view of the new fourdrinier paper machine

consolidation of its pulp mills, the expansion and modernization of its power house and recovery facilities, and the rebuilding of three of its larger existing paper machines.

The new paper machine replaces two small units which had been in operation here for some 40 years and were considered obsolete because they could not produce the newer grades of paper and paperboard now being made at Covington. Since great stress will be placed on the quality and uniformity of the product, the new machine will not result in greatly increased production.

The addition of No. 8 machine gives the mill a line of six paper machines and three board machines, with a total capacity of about 650 tons of paper and paperboard per day. When its "shakedown" is completed, No. 8 machine is expected to produce at the outset about 200 tons per day.

The machine will make heavy grades of bleached paperboard used in the manufacture of food containers, butter cartons, milk bottles, ice cream cartons, paper cups, file folders, and other products.

Although designed primarily to produce heavy weight food container papers, plant officials pointed out that the machine and the extensive auxiliary equipment installed to serve it, are entirely flexible and can be altered easily to produce almost any grade or basis weight which future market conditions might dictate.

In addition to the installation of the machine itself, the paper mill project called for the complete rebuilding of the structure which formerly housed the two older machines, in addition to the installation of a new pulp preparation system and new paper finishing facilities.

Manufactured by the Beloit Iron Works of Beloit, Wis., the machine is a fourdrinier type papermaking unit. From its vacuum-pressure headbox, which automatically controls the flow of pulp and water flurry to the wire at the wet end, until finished paper winds on the reel at the dry end, the operation of the machine is controlled by sensitive and accurate electrical and pneumatic devices which assure a product of top quality and uniformity and greater ease and accuracy of operation through the elimination of many usual manual functions.

A total of 350 electrical control stations are built into the machine, making the instrumentation system one of the most modern and extensive available today. One panel alone, at the wet end of the machine, remotely controls 42 pieces of equipment on the machine. The machine has an extensive alarm system, consisting of electrically controlled horns, sirens, bells, and lights which warn the operators when abnormal operating conditions arise. Another feature is a direct wire telephone system which permits instant communication between crew members at different ends of the machine.

The machine is powered by a 1900-hp. steam turbine which turns a line shaft differential drive capable of propelling the machine at speeds ranging from 200 to 2000 f.p.m. A total of 212 electrical motors, ranging in size from $^1/_6$ to 600 hp., are used to operate various units of the machine, and 25 generators furnish power or function as regulators for automatically operated equipment.

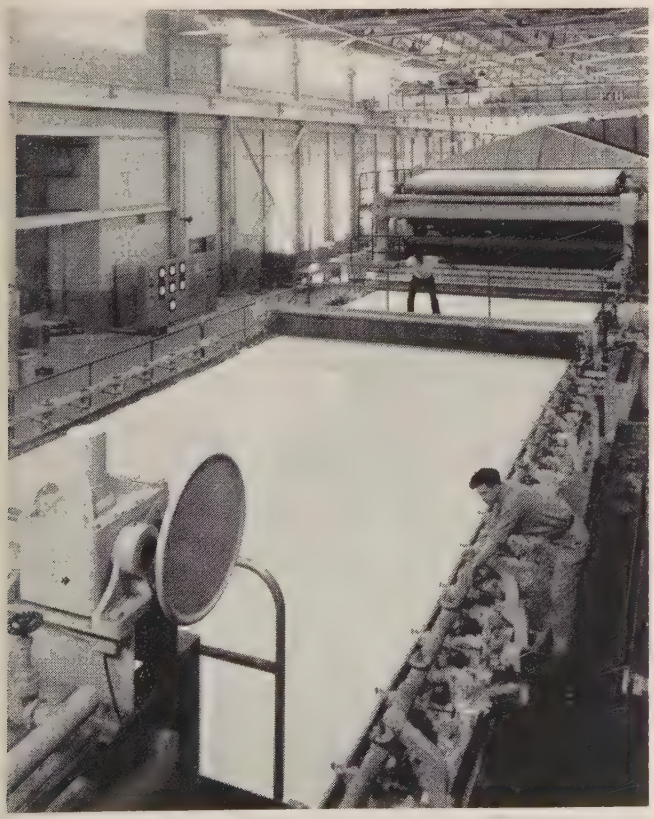
No. 8 machine has a 216-in. wire capable of forming a sheet of paper which will trim to more than 16 ft. in width. The fourdrinier section of the machine is the latest removable type, which permits easier and faster wire changes.

Specially designed to produce high quality papers from local hardwood pulps, the machine is equipped with three press sections, a smoothing press, size press, breaker stack, and two 8-roll calender stacks.

Paper going through the machine is dried by 76 steam-heated steel cylinders of 5-ft. diameter and 15 felt driers. The drier sections are covered with a large hood which forms part of a modern ventilating system, providing not only maximum drying efficiency, but greater comfort to employees who operate the machine as well.

One installation new to machine operations at Covington is a powerful hydrapulper, which is located beneath the dry end. This equipment is used to repulp continuously rejected paper from the machine. It is capable of repulping the entire output of the machine during emergencies. Stock from the hydraulper is pumped automatically to a storage chest for reuse in the system, without the loss of quality because of the introduction of dirt or other impurities. Since it is capable of repulping rolls of paper, this equipment contributes to the efficiency of the operation by reducing time formerly consumed in stripping down rolls for repulping by more conventional equipment.

Other features include an enclosed gear system which contributes to both the efficiency of operation and greater employee safety, and a central, pressurized oiling system which provides greater protection and eliminates manual oiling.



Close-up of the wire section of the new fourdrinier paper machine, designated as no. 8, recently placed in operation at the Covington, Va., plant of West Virginia Pulp and Paper Co.

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The machine is housed in a roomy building which provides easy access to all sections of the machine and an extensive work area. The operating floor is illuminated by 220 750-w. lamps and around 8000 smaller units needed for lighting in the machine area.

An advanced stock preparation system, specially designed for the most efficient utilization of local hardwoods, which are being used in large volume in the manufacture of some grades of paper, has been installed to serve No. 8 machine. The stock preparation system regulates the flow and consistency of pulp prepared for the various grades of paper and paperboard being made here.

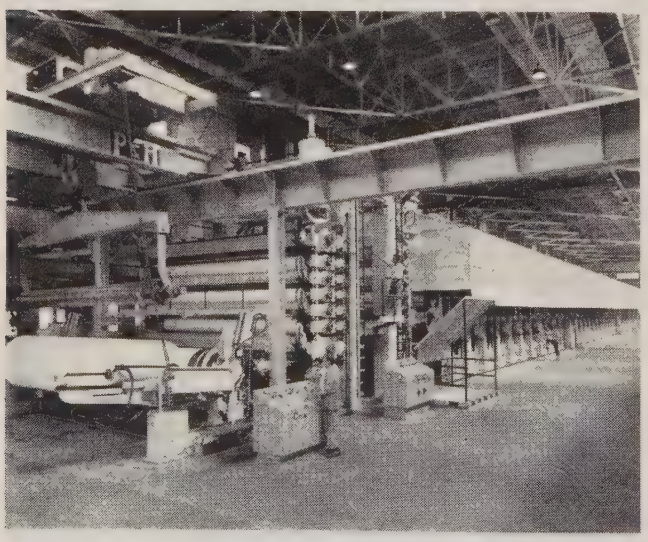
Among the devices installed for quality purposes is a large battery of Dirtecs, centrifugal dirt removers which separate dirt and other foreign substances from the pulp, in order that the paper may be manufactured according to high standards of cleanliness required for food and other sanitary papers.

The machine will also have a Waco filtering system which removes fine fibers from the water used on the machine, permitting the reuse of both. This system reduces the drain on river water used in the papermaking process, a serious problem for the mill in times of low water, provides greater efficiency in the utilization of pulp through its fiber recovery system, and will contribute to further improvement in stream conditions.

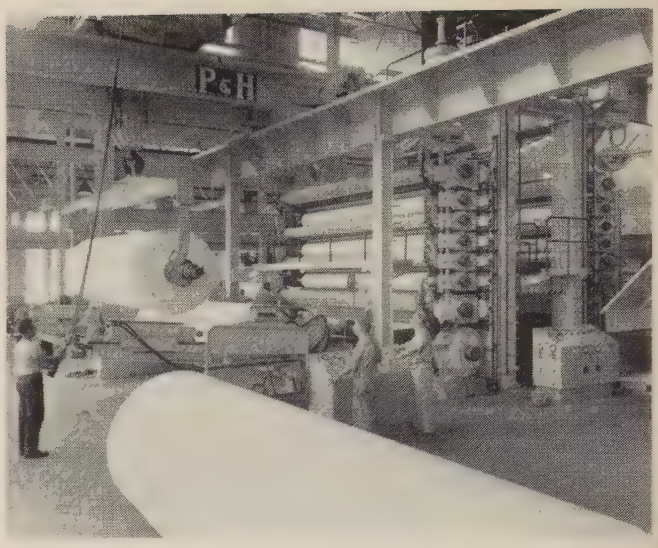
Other auxiliary equipment installed to serve No. 8 includes a Beloit rewinder, highly mechanized and automatic, which rewinds log rolls from the machine and slits them into rolls of customer size. Other equipment for finishing paper includes a table with devices designed for easier handling of the heavy rolls during inspection, wrapping, and stenciling, and an automatic heading machine which seals with heat the heads of rolls, providing a more serviceable and attractive package for shipment to the customers. Electrically driven overhead cranes move rolls from the reel of the machine to the finishing equipment, which is located parallel to the dry end of the machine.

Installation of the machine and its auxiliary equipment in the paper mill called for an ingenious performance in planning and engineering, in order to minimize the production losses resulting from the shutdown of the two older machines, Nos. 3 and 4, which partially occupied the space allotted to the New No. 8 machine.

In order to keep the two older machines running as long as possible, crews reconstructed the building and installed the fourdrinier section of the new machine and the calender stacks and reel of the dry end, along with the rewinder and finishing equipment, while Nos. 3 and 4 remained in operation. During this same period a large part of the electrical and piping installations for the new machine were made.



View from the dry end of new no. 8 paper machine recently placed in operation at Covington, Va., plant of West Virginia Pulp and Paper Co.



The dual calender stacks and the reel assemblage, along with the console control panels used to operate this equipment

When these jobs were completed—at the end of March—the two old machines were dismantled and the remaining sections of the new machine were installed. No. 3 machine was sold to a paper manufacturer in Ohio and No. 4 was dismantled for parts.

Suppliers for No. 8 paper machine:

Beloit Iron Works, Beloit, Wis.	Machine and winder
J. O. Ross Engineering, New York, N. Y.	Air system and hood
Shartle Bros. Machine Co., Middletown, Ohio	Stock chest agitators and hydrapulper
Midwest Fulton Machine Co., Dayton, Ohio	Drier drainage system
Improved Machinery Corp., Nashua, N. H.	Couch pit, machine, and beater chest agitators and stock thickeners
Bird Machinery Corp., South Walpole, Mass.	Dirtecs and felt conditioners
Mason-Neilan Regulator Co., Boston, Mass.	Control instruments and valves
DeZurik Shower Co., Sartell, Minn.	Consistency regulators and valves
Reliance Electric & Eng. Co., Cleveland, Ohio	VS units, motors, controls
Valley Iron Works, Appleton, Wis.	Roll header
Westinghouse Electric Corp., Pittsburgh, Pa.	Turbine drive, motors, electric equipment
Trimbey Machine Works, Glens Falls, N. Y.	Stock meter
Sutherland Refiner Corp., Trenton, N. J.	Stock refiners
Nash Engineering Co., South Norwalk, Conn.	Vacuum pumps
Ingersoll-Rand Co., Phillipsburg, N. J.	Pumps
Stebbins Engineering & Mfg Co., Watertown, N. Y.	Tile linings and stock chests
Harnishfeger Corp., Milwaukee, Wis.	Machine room cranes

South's Pulpwood

In 1952, for the third straight year, the South harvested a record amount of pulpwood and easily kept its position as the Nation's chief pulpwood-producing region. A report released recently by the Forest Service, U. S. Dept. of Agriculture, shows that the 12 Southern States last year cut a total of 14,600,000 cords of pulpwood. This was considerably more than half of the total United States cut of 25,000,000 cords for 1952.

The report was prepared by W. S. Stover and J. F. Christopher, of the Southern Forest Experiment Station, New

State	No. of mills	Mill capacity, tons of pulp per day	Pulpwood produced, thousand cords 1950	1951	1952	Counties with highest production
Alabama	7	1,973	1,321	1,406	1,609	Baldwin, Washington, Mobile
Arkansas	2	975	604	614	620	Union, Grant, Clark
Florida	9	4,290	1,385	1,490	1,583	Alachua, Marion, St. Johns
Georgia	7	3,640	2,221	2,370	2,513	Camden, Clinch, Charlton
Louisiana	8	4,560	883	1,111	1,235	Livingston, Union, Winn
Mississippi	6	2,453	1,666	1,793	1,865	Copiah, Jasper, Rankin
North Carolina	5	2,250	1,024	1,305	1,332	Jackson, Columbus, Bladen
Oklahoma	0	....	39	45	35	Le Flore
South Carolina	3	2,836	1,183	1,251	1,276	Georgetown, Fairfield, Horry
Tennessee	4	380	144	192	268	Putnam, McMinn, Cumberland
Texas	2	1,000	922	1,158	1,160	Montgomery, Liberty, Houston
Virginia	10	2,508	1,044	1,326	1,069	Buckingham, Bedford, Amherst
Total	63	26,865	12,436	14,061	14,565	

Orleans. The Southeastern Forest Experiment Station, Asheville, N. C., and the Southern Pulpwood Conservation Association, Atlanta, Ga., cooperated in gathering the information.

Stover and Christopher estimated that the South's pulpwood cut in 1952 was nearly 4% larger than in 1951, and 17% greater than in 1950. All Southern States except Virginia and Oklahoma showed increases. The largest rises were in Alabama, Georgia, and Louisiana.

Georgia was the South's leading producer, with $2^1/_2$ million cords. Mississippi ranked second with 1,800,000 cords. Alabama and Florida were next with about 1,600,000 cords apiece, and all other Southern States except Arkansas, Tennessee, and Oklahoma produced more than a million cords apiece.

Thirty-nine counties, distributed throughout the South, had cuts of more than 60,000 cords apiece. Baldwin County, Ala., led with 130,000 cords. Livingston Parish, La., was second with 111,000. Other high-ranking counties were Georgetown, in South Carolina, Copiah in Mississippi, and Alachua in Florida.

Stover and Christopher estimated that the South probably also leads the Nation in the manufacturing capacity for turning the raw wood into pulp. At the close of 1952, they reported, the region had 63 pulp mills with a total capacity of 26,900 tons of pulp daily. Six new southern mills, with a projected capacity of over 2300 tons daily, were under construction.

Louisiana's 8 mills lead the South with a total daily capacity of 4600 tons of pulp. Florida has 9 mills, with a capacity of 4300 tons per day. Georgia ranks third in mill capacity and South Carolina fourth.

More and more hardwood trees are being used for pulp, the report noted. Last year, hardwood made up 1,700,000 cords of the South's total, a gain of 17% over 1951. This trend is encouraging, Stover and Christopher said, because the South has a rather plentiful supply of hardwood trees suitable for pulpwood, while pine is at a premium.

Copies of the report are available from the Southern Forest Experiment Station, 2026 St. Charles Ave., New Orleans 13; or from the Southeastern Forest Experiment Station, Box 2570, Asheville, N. C.

Badger

Spurred on by encouraging results from its tests in lagooning spent sulphite liquor to reduce sulphite pollution of the Peshtigo River, Badger Paper Mills on July 16 almost doubled its lagooning operation.

For several months the company has been hauling 50,000 gal. a day of liquor to a lagoon for processing to remove the dissolved wood sugars and thus improve the stream condition for fish life. Now this has been stepped up to 90,000 gal. a day.

To make its lagooning test, Badger Paper Mills purchased 160 acres of sandy land surrounding a hairpin bend of the river two miles from its mill. In the middle of this area bulldozers scooped out 2 ft. of sand and used this for dikes surrounding a 4-acre rectangular lagoon. A 3000-gal. tank truck makes the round trip every half hour, hauling spent liquor from the pulp mill and dumping it at the upper end of the lagoon.

As the liquor flows across the lagoon much of it sinks into the sand. Only during the Spring thaw has the lagoon looked like a real pond. Tests of soil in the dike walls and outside the lagoon show that the fluid is greatly changed for the better as it seeps through.

Technical experts of the State Committee on Walter Pollution and of the Sulphite Pulp Manufacturers' Research League staff are working with Badger Paper Mills' technical men to learn exactly what happens to the liquor while it remains in the soil. They report indications that soil bacteria are digesting the liquor solids in much the same manner as these operate on organic matter in a swamp. Liquid now being tested from the dike seepage looks like clear, odorless water. The condition of the river below the lagoon is substantially improved since lagooning got under way.

Top scientists of the League's 15 member mills inspected Badger's lagoon recently and agreed that thus far it looks promising. They warned against undue optimism about lagooning as a solution for all mills.

"Few mills in Wisconsin are situated within economical hauling distance of a site where a lagoon could be built with such excellent natural characteristics as we found near by," said John A. Hanson, sulphite superintendent and technical adviser of Badger Paper Mills. "Even with the good results we have had thus far, we cannot yet be sure that the operation is a lasting success. When eventually we are sure, we shall probably install some method of getting the liquor to the lagoon with larger capacity and greater economy."

NEPCO

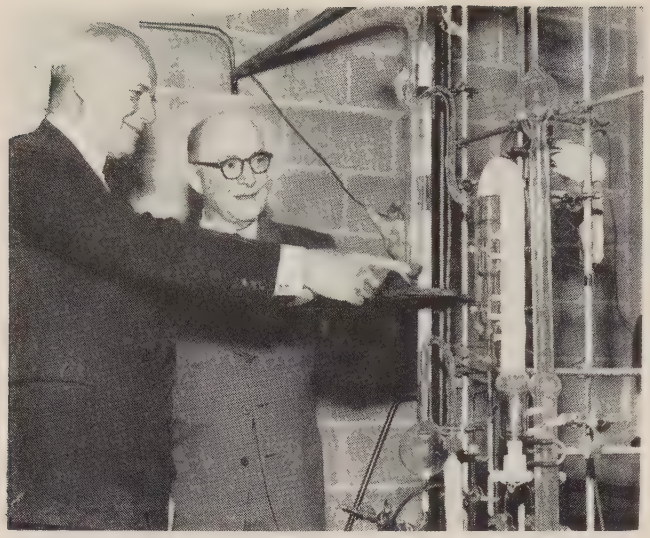
An offer of a 4.6% general wage increase has been accepted by four unions representing production and maintenance employees of Nekoosa-Edwards Paper Co. The wage boost was effective as of June 1, 1953.

Another provision of the new contract which is in effect until May 31, 1954, provides for reducing the probationary period for new employees from 45 to 31 days. The contract also calls for establishing a new training program for mechanics including a revised rate schedule and other improvements. In addition individual adjustments with the various unions were also negotiated.

The unions, representing some 1400 hourly paid employees, are Local No. 59, International Brotherhood of Paper Makers, Lodge No. 1543, International Association of Machinists, Local No. 52, International Brotherhood of Pulp, Sulphite and Paper Mill Workers, and Local Union 807, United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry of United States and Canada.

Rayonier

Establishment of a $2500 graduate fellowship by Rayonier,



University of Washington President, Henry Schmidz, showing some of the University's chemical research equipment to Arthr N. Parrett, vice-president in charge of research and development of Rayonier, Inc.

Inc., and a $1000 undergraduate scholarship by the Rayonier Foundation was announced on June 11 by the University of Washington.

The grants, available to students in the College of Engineering, are the largest ever to be made in the University departments concerned.

The fellowship will be given to an outstanding chemical engineering graduate student for research in the fields of cellulose and silvichemicals. Silvichemistry is a new w rd, coined recently by Rayonier, to describe the branch of wood chemistry concerned with chemicals, other than cellulose, that are found in wood.

The scholarship will be given to a student who will be a senior next year in the departments of chemical, mechanical, or electrical engineering. It will be awarded on the basis of scholarship, leadership, and professional promise.

Rayonier is also establishing a $1000 scholarship at the University of Florida and a $2500 fellowship at Georgia School of Technology. The company operates a chemical cellulose plant in Florida and has a new plant under construction in Georgia, in addition to operating three plants in Washington.

Dr. Arthur N. Parrett, vice-president in charge of research and development of Rayonier, Inc., said the grants are being made to encourage outside study in the important fields of wood chemistry.

"With intensified studies under way here and elsewhere, another important segment of the new chemical era may well develop," he declared. "Rayonier hopes that new ways will be discovered to make more complete use of the materials now resulting from chemical cellulose production, but not now utilized commercially."

Rayonier has continually supported one or more research and development projects at the University for many years, Dr. Parrett said.

In accepting the grants, Dr. Henry Schmitz, president of the University, pointed out that the expansion of the Rayonier fellowship and scholarship programs could prove to be of significant value to industry. He commented:

"Grants such as these not only reward deserving students, but they also are a stimulation for outstanding accomplishments that will be reflected in our economic and industrial life for many years to come."

In 1930, technical achievements by Rayonier made possible the production of the first chemical cellulose from western hemlock suitable for rayon manufacture. During the past 20 years, research by company scientists has led to many improvements in the quality of cellulose, as well as achieving production of several different types of cellulose.

Rayonier, Inc., currently constructing a $25 million chemical cellulose plant at Jesup, Ga., is soon to build an office building on Walnut St. between Whaley and Wayne Sts., according to Russell F. Erickson, vice-president in charge of engineering, who described it to the Wayne County and Jesup Chamber of Commerce annual meeting in Jesup on July 8.

The new building, to house the company's Southeast Area Office, will be single-story brick, covering approximately 4200 sq. ft., Mr. Erickson said. Architecturally it will follow a design similar to that of the administrative offices located at the plant site. Construction is scheduled to begin about Aug. 1, 1953.

At the Rayonier executive offices in New York, James T. Sheehy, executive vice-president, explained that the new office building will house the purchasing, traffic, industrial relations, and area comptroller's departments for Rayonier's operations in Georgia and Florida.

Joseph B. Talbird, assistant company comptroller, Walter Thad McDaniel, head of Southeast Industrial Relations Div., and E. J. Johnson, purchasing agent, will operate their departments at the Walnut St. location.

Buyers and procurement men of the Rayonier Southeast Timber Div., headed by J. Rex Nance, will also have offices in the new Jesup building. The division is headquartered at Fernandina Beach, Fla.

Language Is Still Growing

Latest Word: Silvichemistry

No modern language had the word for it. So Dr. Arthur N. Parrett, vice-president in charge of research for Rayonier, Inc., created it to describe a new and important branch of chemistry.

It's "silvichemistry." It describes that branch of chemistry specializing in the study of those complex, organic chemicals, other than cellulose, stemming from wood. Dr. Parrett has termed this group the "silvichemicals."

Found in all wood, its function is to act as a binding agent for cellulose. Dr. Parrett said that for years science has understood and worked the cellulose molecules. From chemical cellulose scientists have made rayon, acetate, cellophane, tire cord, and hundreds of useful modern products.

"But the silvichemicals have virtually gone to waste," he related. Hundreds of thousands of tons each year are put to little or no use. Rayonier researchers have been endeavoring to unlock the mystery of the silvichemicals. When they do, they feel confident that another useful segment of our chemical age will have arrived."

In the meantime several universities have received Rayonier fellowships and other grants to devote intensive study to this branch of chemistry, unidentified until Dr. Parrett correctly dubbed it silvichemistry.

The word's prefix, silvi, stems from the Latin for wood.

Rayonier says progress is being made in silvichemistry, that new products can be looked for within the near future.

Question in Dr. Parrett's mind: How long will it take lexicographers to discover "silvichemistry" and make it part of our language? Nearly every schoolboy knows "petrochemistry" and "petrochemicals." Yet after 20 years they haven't found their way into dictionaries.

Emanuel J. Johnson has been appointed purchasing agent for the southeast area of Rayonier, Inc., Jesup, Ga., according to an announcement made here July 8 by William E. Breitenbach, vice-president in charge of production.

In this new position Mr. Johnson will be responsible for all Rayonier purchasing in the southeast. He will make his headquarters at Rayonier's newly announced Southeast Area Office in Jesup.

Mr. Johnson has been associated with this leading chemical cellulose producer since 1937 when Rayonier began construction of its fourth plant located at Fernandina Beach. He has handled purchasing for the Fernandina Div. since that date.

Born and educated at Pensacola, Fla., Mr. Johnson has a background comprising law, mill supplies, construction, shipbuilding, ship repairs, and pulp mills. He is married to the former Norma Holt of Savannah, Ga., and has two married sons. A daughter, Mary Holt, will reside with the family at their new home in Jesup.

H. & W.

Girdling of hardwoods in Choctaw County, Ala., is paying off in fully stocked stands of free-growing young pines for Hollingsworth & Whitney Co.

When the firm acquired its well-drained, upland acreage in that area some years ago, many of the sites were heavily stocked with low-grade, worthless stands of scrub hardwoods. Loblolly and shortleaf pine seedlings were becoming established under much of the scrub oak, only to die off in a few years.

Fire protection was established and then foresters began their program of hardwood eradication, but only in those areas which were already supporting fair to well-stocked stands of pine reproduction under scrub hardwoods.

Every attempt is made to sell all merchantable hardwoods prior to girdling. Hardwoods 3 in. DBH and larger are girdled, along with smaller trees with unusually widespread crowns. Sound, young poplar is untouched.

Girdling is done the year around. In 1950, Hollingsworth & Whitney started with a three-man girdling crew. Today, seven men are employed full time in the girdling project, which since 1950 has seen more than 8000 acres treated.

In one area seedlings have grown from 3 to 6 ft. in height in one growing season, 2 years after girdling. On an ungirdled check plot on the same hillside, the average seedling of the same original size grew only 12 to 15 in. during the same time.

Company foresters have found that a shallow girdle, just deep enough to sever the cambium layer, cut completely around the tree is far more desirable than a deep notch or deep cuts into the heartwood. Sprouting is more vigorous after deep girdling; shallow girdling betters the chances of the dead tree standing longer and breaking up limb-by-limb without the resulting damage to young pines caused by a large tree falling with its crown intact; and notches or excessively deep cuts increase the cost of girdling.

St. Regis

St. Regis Paper Co. has announced the sale of the company's sawmill at Fargo, Ga., to the Suwannee Longleaf Manufacturing Co. In addition, the company has entered in an agreement for 10 years with the purchasing company to sell it stumpage equal to a minimum of 12,000,000 board feet annually from the Suwannee tract which St. Regis holds under long-term lease.

G. R. Lyons of Alberta, Ala., and well known in southern lumber circles as former president of Frost, Sibley Lumber Co., is president of the newly formed Suwannee Longleaf Manufacturing Co.; J. P. Driver, Selma, Ala., is secretary; and D. Lyons, Alberta, Ala., has been named general manager.

The Fargo sawmill, which has a capacity of 1,000,000 board feet a month on a single shift basis, was built by St. Regis in 1949 and not long after the company had acquired the management rights to the 220,000-acre Suwannee tract in Georgia for a period of 60 years. It was built by St. Regis in order to provide a profitable source of consumption of the forest crop from the Suwannee tract until such time as the company had completed its new kraft pulp and paper mill in that area. This tract is now one of the major pulpwood resources for the company's recently completed Jacksonville mill.

Announcement is made by St. Regis Paper Co. that Walter DeLong, a vice-president and director of the company, retired from the position of resident manager in charge of the company's operations at Tacoma, Wash., on June 30. He is, however, continuing to serve in an advisory capacity. Mr. DeLong joined St. Regis in October of 1942.

Jack M. Lamb, who joined St. Regis in 1928 and has been in charge of purchasing at the company's Tacoma operations, has been appointed to succeed Mr. DeLong as resident manager. Robert DeLong has been named assistant to the resident manager at Tacoma in charge of wood procurement.

Fred E. Chittick, who joined St. Regis on July 1, 1943, and has been in charge of woodlands and wood procurement for the company in the northwest, retired on June 30, but will continue to serve in an advisory capacity.

July 1, 1953, marks the end of the first 5 years of operation of the company's Retirement Plan. Under a company policy effective July 1, 1953, mandatory retirement is required on the part of all employees who have reached 70 years of age or over.

St. Regis Paper Co. announced that William H. Anders, resident manager of the East Pepperell, Mass., mill of the company retired from that position on June 30, but is continuing to serve in an advisory capacity at East Papperell. Mr. Anders was formerly president of the Nashua River Paper Co. at East Pepperell, Mass., with which he became associated in 1919. He joined St. Regis when it acquired that company in 1946.

Robert A. Chase has been appointed resident manager at the East Pepperell mill in succession to Mr. Anders, with Russell Hamilton, heretofore general superintendent, named mill manager. Mr. Chase will continue in charge of kraft sales in the New England area.

Marathon

Chemical research has found a new use for a previously unutilized by-product derived from sulphite pulp manufacture, Marathon Corp. announced recently.

This material, called Maracarb N, is now being sold to chemical manufacturers to increase the useful life of some lines of agricultural chemical supplies. Many of the most widely useful pesticide powders and dusts contain chemicals which tend to lose strength either in manufacture or afterward. The new sulphite by-product material has proved very effective in nullifying this tendency, thereby prolonging the effective life of the pesticides.

Marathon Corp. pioneered the Howard Process by which the wood solids in spent sulphite liquor are converted into raw material for dozens of high-grade chemical products ranging from food flavoring to tanning extracts. Material thus removed from the liquor no longer has to be released to the river, and in consequence less of the dissolved oxygen is used up from the stream.

Development of the new product is good news for fishing enthusiasts, since it employs one of the sulphite pulping by-product materials for which no use was previously known. Processing it and shipping it to formulators of pesticide products keeps it out of the river, and leaves more dissolved oxygen in the water for fish and other aquatic life.

Hoberg

Its $2,500,000 plant project for keeping wood sugars out of the Fox River and Green Bay is coming along well on schedule, Hoberg Paper Mills told the State Committee on Water Pollution recently in a progress report for the first half of 1953. Construction has been under way for more than 3 months, and much of the plant equipment is already delivered or in process of manufacture by suppliers.

Hoberg is putting up the huge plant to comply with a State order to reduce the quantity of wood sugars now going into

the stream. It will utilize a process recently perfected by Wisconsin pulp and paper industry researchers for manufacturing a useful product from these wholesome sugars that are dissolved out of the wood chips in the process of making pulp.

In his company's report M. J. Auchter, vice-president of manufacturing, reminded state authorities that the project consists of three phases. A tunnel more than 6 ft. square inside and 3150 ft. long will bring steam from the boiler house to operate the plant. The factory itself, of more than a half-million cubic feet, will manufacture torula yeast from spent sulphite liquor. An installation of pumps and tanks and presses will collect the liquor for processing.

The tunnel is far along, Auchter reported. More than half of the tunnel construction is completed, in barely half the contract time. The two tremendous fans for ventilating the tunnel have been delivered, and the rest of the equipment is in process and on order.

Yeast plant equipment is in various stages of delivery and manufacture and is well under control, Auchter stated. Foundation plans will soon be ready to submit to the state Industrial Commission, and construction will start promptly after this official approval is received.

"We will most likely be pioneering in the development and application of more or less conventional kraft liquor collection facilities to spent suphite liquor collection," Auchter stated in his report. "We are spending more time in investigations and studies on this than was originally deemed necessary. However, we are certain that these longer than anticipated studies on liquor collection facilities will not interfere with the completion or start-up of our yeast plant."

Heart of the Hoberg torula yeast plant will be the process worked out as a sulphite pollution abatement measure by the scientific staff of the Sulphite Pulp Manufacturers' Research League, Appleton. This is the organization for sulphite liquor research that is cooperatively maintained by 14 Wisconsin sulphite pulp mills.

The process places torula yeast organisms in spent sulphite liquor, where they propagate rapidly under scientifically controlled conditions. The yeast eats the sugars which otherwise would go into the stream, where sugar decreases the supply of dissolved oxygen available for fish. After propagation, the yeast is separated from the desugared liquor and dried. In this state torula yeast is a vitamin-rich protein substance that is rapidly gaining ever greater acceptance as a supplement for animal foods and as a material from which are derived important human nutrients and pharmaceutical products.

Flambeau

This July rounded out the tenth year of Wisconsin's longest established installation for providing adequate dissolved oxygen downstream from a sulphite pulp mill. In 1943 the Flambeau Paper Co. in cooperation with the Sulphite Pulp Manufacturers' Research League began pumping oxygen into the waters of the Flambeau River whenever the oxygen level fell below that needed for tip-top fishing conditions.

Fish depend upon dissolved oxygen for their bodily needs, and the only damage that ever could be caused by spent sulphite liquor is that it may indirectly use up some of the dissolved oxygen. The scientists decided to try replacing the lost oxygen by pumping compressed air back into the water, thus relieving any unfavorable results of the sulphite liquor on marine life.

The pioneer installation was tested out at the paper company's Pixley Dam, some miles downstream from the mill. Here compressed air is diffused or bubbled into the water just before and just after the water wheels. A study of the results made some time ago by Theodore F. Wisniewski, now director of the Committee on Water Pollution, in cooperation with Averill J. Wiley, now technical director of the Sulphite League, shows that this aeration shortens by 10 miles the zone of oxygen deficiency in the Flambeau River.

The Pixley Dam project fits conditions on the Flambeau, a relatively small stream, and the equipment operates during the warm weather months and at any other times when reaeration might possibly improve stream conditions. But scientists agree it could not be used successfully on a much larger river. That is probably why, although it has been so successful, this is the only project in the world for aerating an entire river's flow.

Scottissue

Scott Paper Co. has announced the election of Paul C. Baldwin as vice-president. Mr. Baldwin, who is in charge of the company's West Coast operations, has been an assistant vice-president since 1951. He will continue to operate under the direction of U. M. Dickey, Scott's senior officer on the Coast.

Mr. Baldwin joined Scott Paper Co. in 1940 as an assistant in the pulp laboratory at the Chester, Pa., plant. After further experience in pulp testing and as technical control director, he became paper mill superintendent in 1943. He was named manager of the Chester plant in 1947.

In 1950, he was appointed assistant to the general operating manager. He was made an assistant vice-president shortly after the merger in 1951 of Soundview Pulp Co. and Scott.

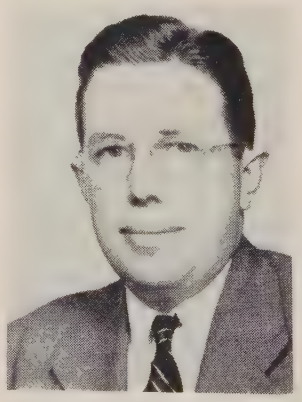
Mr. Baldwin is a graduate of Syracuse University and holds masters and doctors degrees in chemistry, both from The Institute of Paper Chemistry.

Scott Paper Co. directors have approved the expenditure of approximately 12 million dollars for construction of a second paper machine on the West Coast, Thomas B. McCabe, president, announced recently. The new machine will be housed in a building now under construction at Everett, Wash., for Scott's first West Coast paper machine. Plans are being expedited, Mr. McCabe said, so that the second paper machine will be completed shortly after the first of next year when the first machine is expected to go into operation.

Mr. McCabe estimated that completion of the second paper machine will add about 200 employees to the Everett plant's payroll.

The two machines will be adjacent to the company's large bleached sulphite pulp mill at Everett which was acquired in 1951 when Scott merged with Soundview Pulp Co. Pulp from the mill will be piped directly to the paper machines. Since Scott acquired large timber resources on the Coast as a result of the merger, completion of the first paper machine will give them an integrated operation—from tree to finished paper—on the West Coast.

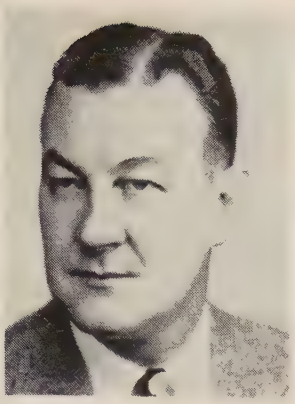
Production of pulp on the West Coast has also been stepped up by improvements to equipment and processes. The company's West Coast pulp production will be sufficient to supply pulp for Scott's market pulp customers as well as for the two new paper machines.



P. C. Baldwin, Scott Paper Co.

F. W. Plowman, Scott Paper Co.

D. A. Prouty, Scott Paper Co.



Paul Brown, Scott Paper Co.

Scott recently announced plans to increase its sales to $300 million annually by 1958 and Mr. McCabe said that the output of the two new machines will contribute considerably in helping to meet the sales objective.

Scott Paper Co. has announced the designation of vice-president Francis W. Plowman as assistant to the president and the election of D. A. Prouty to the newly created post of assistant vice-president in charge of public relations. Paul Brown will replace Mr. Prouty as national retail sales manager, the announcement stated.

Thomas B. McCabe, president, said that the moves are part of the company's comprehensive program to reach a sales goal of $300,000,000 annually by 1958. Scott's sales of finished paper products for 1952 were $129,168,565, the highest in the company's history.

"To reach this new goal," Mr. McCabe said, "will require a comprehensive program and the correlation of our activities in such a manner as to assure the highest degree of unity among the various divisions of our business." He said that Mr. Plowman is ideally suited to head up the development of this program.

Since its establishment 5 years ago, Scott's public relations function has operated as an arm of the advertising department, under the direction of G. A. Duff, manager of public relations, who will continue in this capacity. "The time has now come," Mr. McCabe said, "to designate the public relations function as a major division of the business and to place it under the immediate supervision of a member of the president's staff."

He said that rapid expansion attaches ever greater importance to the company's public relations program. "Today," Mr. McCabe said, "our company is a leading corporate citizen in the many widely separated communities in which Scott plants are located. Our television activities, which have ushered us into millions of America's living rooms, have not only increased the demand for Scott products but have also greatly stimulated the interests of the public generally in the company that makes those products. We must be prepared to accept an even greater share of civic responsibility in the future, and we naturally are anxious to discharge that responsibility in a manner that will reflect credit upon Scott Paper Co. and its men and women."

Mr. Plowman, a vice-president and director of Scott, has been general sales manager since July 22, 1943. He joined Scott in 1928 and in 1938 was made assistant controller. He entered sales research and promotion in 1940 and when Scott established its subsidiary, Marinette Paper Co., in 1941, he was placed in charge of that division's sales activities.

D. A. Prouty, national retail sales manager, joined Scott in 1926 as a salesman in Chicago. After serving as retail district sales manager in several cities, he was elevated to his present position in 1938. During his tenure as national retail sales manager, Scott's retail sales have increased 730%.

Paul Brown has been with Scott since 1931. He was named St. Louis district manager in 1934, and Los Angeles district manager in 1937. He has been Southern retail divisional sales manager since 1946.

Mr. McCabe also announced the formation of a distribution committee to direct and coordinate the company's sales, advertising, marketing research, traffic, and related activities. Members of the committee are: J. D. Bowden, manager of Marketing Research; Paul Brown, retail sales manager; H. R. Hvid, assistant industrial sales manager; Harry C. Pardee, assistant vice-president and director of advertising; and F. L. Witt, assistant industrial sales manager.

Olin Cellophane

The appointments of Linton E. Simerl and Arthur H. Landrock to the Research & Development Dept. of the Olin Cellophane Div. of Olin Industries, Inc., has been announced by Edward Hartshorne, Research Dept. manager.

Mr. Simerl, who becomes chief of the Packaging Development Section, was formerly a supervisor of the Process Engineering Dept. of the Marathon Corp. and had previously been associated with the St. Joe Paper Co., Brown Co., Mead Corp., and the Dow Chemical Corp.

A native of Chillicothe, Ohio, Mr. Simerl was graduated from Ohio State and received his doctorate from The Institute of Paper Chemistry.

Mr. Landrock, who has been named senior packaging technologist in the Packaging Development Section headed by Mr. Simerl, is a graduate of Queens College and received his masters degree from Boston University.

An infantry officer in World War II, Mr. Landrock had previously been associated with the Contintenal Can Corp. and had served in the Dept. of Food Technology at M.I.T.

Ecusta

A million pounds is a lot of paper. It represents almost 3% of Ecusta's annual production.

Yet, the Watch Tower Bible & Tract Society, who purchased this paper from us, and for whom it was specially developed, will convert it into 1,500,000 copies of the DeLuxe Edition of the New World Translation of the Christian Greek Scriptures in less than 2 years. These Bibles will be distributed to the "four corners of the earth" at the phenomenally low price of $1.50 per copy. What is more, some who cannot afford this cost price get them free.

To appreciate fully how this is possible, you would have to visit the headquarters of this Society in Brooklyn, N. Y. It is entirely a nonpolitical, nonprofit, noncommercial, charitable, religious corporation, devoted to Bible education. In 1942 the Society succeeded in purchasing plates of the complete King James Version of the Bible, and since then has distributed upward of 900,000 copies. In 1944, it purchased the use of the plates of the American Standard Version, and 304,000 copies have been printed and distributed. In all, they have printed and distributed over 600,000,000 copies of various publications in about 100 different languages since 1921.

The pressroom occupies one floor of the modern plant on Adams St. in Brooklyn. Ecusta paper is printed from rolls on two of the four slower rotary presses (8000 impressions per hour). The two new presses print from rolls and turn out finished magazines at the rate of 29,000 impressions per hour.

Watch Tower's World Headquarters is Bethel Home on Columbia Heights in Brooklyn, overlooking New York harbor. This modern building contains the executive offices of Jehovah's Witnesses, and houses 450 workers of the Society. These volunteer workers devote $8\frac{1}{2}$ hours a day, 5 days a week, and half day on Saturday, to duties such as running presses, working in the laundry, carpenter shop, cobbler shop, kitchen, tailor shop, library, power department, and legal department. To illustrate the scope of their legal department, they have carried 45 cases to the Supreme Court of the United States and have received 34 favorable decisions.

Another duty is the operation of their radio station, WBBR. It is a noncommercial, educational station, operating 7 days a week.

To show further self-sufficiency of the group, they have two doctors, a dentist, barber, tailor, and members of other professions. Their fruit, vegetables, meat, butter, and eggs are produced on their three farms in New York and New Jersey. In other words, everything is furnished through mutual cooperative effort except clothing, for which each worker receives a nominal monthly stipend.

The Watch Tower Bible and Tract Society was founded in 1872. Incorporated in 1884 as Zion's Watch Tower Tract Society, the present name was adopted in 1896.

Their first publication, the *Watchtower*, began in a small way, the first issue being 6000 copies. By 1904 circulation was 25,000. Now the current issue, printed in 38 languages, is about 1,500,000 copies. The entire first edition of 6000 copies could be printed on one of their modern presses in 12 minutes.

Brown Co.

Extras paid by the Brown Co., Berlin, N. H., to employees are as follows:

Company's share only	*Value to each employee, ¢ per hr.*
Night or shift differential	1.7
Social Security payments made by the company to the Government which when added to retirement pay by the company help us live more comfortably when we retire	2.3
Unemployment Compensation payroll tax	2.3
Workmen's Compensation (estimate cost of self-insured)	1.9
Company contribution to Pension Plan	9.1[a]
Company contribution to life insurance premium	1.0
Company contribution to sickness, accident, surgical, or medical care insurance, hospital insurance, etc.	1.3
Paid rest periods, lunch periods, wash-up time, clothes change time, etc.	2.6
Vacations for relaxation, and to do some of the things we didn't have time for during the rest of the year	6.2
Holidays to celebrate important events or to hunt, to go fishing, etc.	3.3
Extra pay to employees working on Sundays	2.6
Pay to men in National Guard	0.2
Payments to union stewards or officials for time spent in settling grievances or in negotiating agreements	0.06
Total extra pay per hour for each worker	34 1/2¢
The average extra payment made by the company per worker per year	$718.85

[a] Assumes a 20-year funding of past service liability.

Peeling Hardwood

Rough hardwood is often difficult to market as pulpwood, but peeled wood finds readier markets and also brings a higher price. To determine the relative ease of peeling beech, red maple, and yellow birch, a study was made at the Paul Smith Experimental Forest in the Adirondacks of New York.

Common woods practice is to peel the entire bolt in one piece and then cut it into 4-ft. bolts. In this study, however, the wood was peeled in 4-ft. bolts to eliminate the effects of such variables as clear bolt length, roughness of bolt, and lay of the tree.

Species	*Bolts peeled, no.*	*Average diameter outside bark, in.*	*Time per bolt, min., sec.*
Beech	15	8.58	3:24.7
Red maple	14	7.06	1:33.7
Yellow birch	32	6.60	1:11.1

The study was made at the peak of the peeling season. All wood used was peeled within 4 hours of felling.

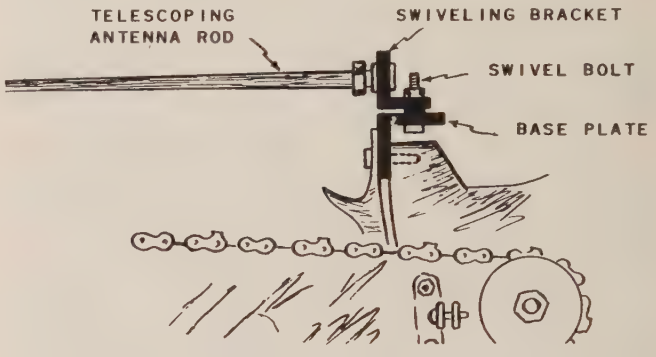
In peeling, the bolt was leaned against a notched log, which served as a simple peeling rack. Bark was removed with a short-handled (16-in.) hemlock spud.

Yellow birch peeled most easily. Its bark was stiff and thick, and it loosened in sheets. Red maple also peeled easily. Its bark was tough, and it separated from the wood in long flexible strips.

Beech was the most difficult to peel. Its bark was thin and brittle, and it came off in narrow strips. Beech bark sets to the wood rapidly: one day in the sun dries out the cambium and cements the bark to the wood.

Yellow birch and red maple were certainly as easy to peel as either spruce or fir. And, in addition, peeling them was clean work—no pitch or resin to gum up tools, hands, and clothes.

A simple measuring rod, easily attached to a chain saw, permits pulpwood cutters to measure bolt lengths and buck the tree into bolts in one operation. By eliminating the separate jobs of measuring and marking, it saves as much as 20 minutes per cord in production time.



This device, made at the Experiment Station's Research Center at Beltsville, Md., employs a car-radio antenna. These can be picked up at any auto junkyard. They are fairly stiff and can be telescoped from about 2 to 5 ft.

The antenna rod is attached to the saw by a simple swiveling bracket, without any alteration to the saw.

The bracket is made of 2 pieces of $1^1/_2$-in. angle iron $^3/_{16}$ in. thick. In this case (for use with a 1-man Homelite saw), a piece 2 in. long is bolted to the bumper shoe of the saw, to form a base plate. Another piece, 1 in. long, with the antenna rod bolted to it, is attached to the base plate with a swivel bolt.

The bolt holes are aligned so the measuring rod lies directly over the saw chain. Equally simple attachment brackets can be made for other makes of chain saws.

Mounted this way, the measuring rod can be swung horizontally 90° to either right or left of the saw bar; or it can be swung straight ahead over the saw bar. In this position, telescoped, the saw can be used for felling without removing the measuring rod. Also, in this position the rod is out of the way when carrying the saw through brush.

This measuring rod attachment is believed to be an improvement over the "Sam Day Measuring Rod Attachment" described in the American Pulpwood Association's Equipment Handbook Release No. 111, April, 1952.

To use the measuring rod, the operator positions the saw so the tip of the rod lies just even with the end of the tree. There he makes his cut. Then he moves along the tree until the tip of the rod is even with the end of the first cut, and he bucks off another bolt. He moves along the tree this way, cutting as he measures.

Since the rod can be swiveled to either side of the saw, he can work along the tree in either direction or saw from either side.

Quality Consciousness

Listed below is a check list which, if you will devote approximately 5 minutes to, will tip you off as to whether you are on the right road toward helping the future security and stability of your company. Our emphasis is on quality work every day, every hour that we are working. In the key competitive paper field such as exists today, it is highly essential for each of us to be quality conscious at all times. Quality is determined by the customer. What he wants, we must give him; if we don't, we have lost a customer. Try it out.

1. Do you know exactly what quality control is expected of you on your job?
2. When work is rejected, do you know what is wrong and exactly why it was rejected?
3. Do you have your own plan of closely cooperating with your supervisor and your fellow employees for the purpose of improving quality?
4. Do you ever ask for a list of all the defective work in your department each week or each month so that you can help take definite steps to prevent similar defective work from happening again?
5. Do you continually inspect the work being done by you and being produced by your department?
6. Do you ever give suggestions to your supervisor on how to improve quality?
7. How long since you have had a personal talk with your supervisor or fellow workers regarding the quality work you are doing?
8. Do you thoroughly check your orders and the bulletin boards to learn facts about quality?
9. Do you know the cost of defective work in your department?
10. Do you take pride in the type of quality work you produce?
11. Do you realize the importance of the relationship of quality workmanship to the security of your job in the department and in the mill?
12. Do you realize the relationship of good workmanship to your own individual opportunity for advancement and promotion?

We hope you have scored yourself accordingly. Recheck your quiz and if you find any "no" answers, then you can assume that you have a job to do with yourself toward helping to maintain quality standards in the mill.

K.-C. in Canada

Its mill is not yet 8 years old. And its facilities consist of a building nestled beside the mighty plant of the affiliated enterprise of the Spruce Falls Power and Paper Co., Ltd., one of the really big ones of the Dominion, housing two wadding machines and their auxiliary equipment. Yet for all its youth, and despite the lack of physical size, K-C of Canada occupies a proud position, important not only in the coporation's scheme of things, but as part of a great change taking place in Canada.

It represents K.-C.'s part in the great postwar boom in the north country. It is a sign that the corporation is expanding with the same youthful vigor being demanded of all Canadian industry. It is a pacemaker in its field just as Spruce Falls has been in another, and as has been the community of Kapuskasing, which is its home.

As clean as the creped wadding that whirls off its two modern mechanized machines is the new two-story mill adjoining the Spruce Falls mill to the east. Its high standard of cleanliness and sanitation is a continuous process for everything from floors to equipment.

As modern as its 2-year-old No. 2 machine that rolls up creped wadding at 2500 f.p.m., as efficient as its entire operation directed by 59 mill and 12 office and technical employees, as smooth an operating unit as the pulp which pours onto its wadding machine screens is Kimberly-Clark of Canada.

And here too is evident the same pride in the mill and production that is a Kimberly-Clark trade mark in each of its other mills in the United States and Canada. The mill's daily steam consumption would heat 50 private homes for an entire winter. The electrical power consumed daily is six times as much as used in the community, the water used each day is seven times that used by the entire town.

As the crow flies north the mill is only 125 miles from salt water, yet deep in the heart of the Canadian timber country. It is 420 air miles or 1235 rail miles from Neenah, Wis., headquarters of Kimberly-Clark, but as close as 10 minutes by teletype or $3^1/_2$ hours by plane.

The Canadian bush is not far from its back door, stretching into some of the most rugged timber lands of Canada. The ageless Kapuskasing River forms a bay at its "front door" and if it had any windows, one could look across the bay to the contemporary "planned" community where its employees live.

The windowless design of the mill is one of its most unusual features. Exterior walls are of solid reinforced concrete. All glass has been omitted to prevent excessive condensation because of the low outside temperature and high humidity of the machine room. The heating and ventilating system takes in enough outside air in winter to replace air exhausted through the machine hood system and the attic process exhaust system. Preheated air is drawn from the adjoining trainshed, washed, and then passed through reheating coils to ducts supplying air along the machine room walls and over the mezzanine floor. In summer, controls permit the ventilating system to take in 100% outside air. Exhaust fans installed in the attic draw out the hot air from grills in the ceiling over the driers.

But the lack of windows is never apparent as one tours or works in the mill. Modern illumination marks the interior to work with the color of the ceramic tile walls, the gray ceiling, and the equipment to provide a cheerful, spacious, bright place for employees.

Kimberly-Clark of Canada is a mill designed for wadding, specifically designed for creped wadding production. Its pulp comes from the adjoining Spruce Falls mill and from Terrace Bay's Long Lac Pulp and Paper Co. Ltd.

The unbleached sulphite pulp (from Spruce Falls) goes through a three-stage bleaching process for further refinement. It is then pumped to the proportioners where it is mixed in desired amounts with sulphate pulp (from Long-Lac) which has been beaten from its baled state to slush in the 12-ft. diameter hydrapulper. The resulting mixture then flows into the machine headbox from where it takes but 3 seconds to become creped wadding. This wadding, with the exception of Kimpak, is shipped to Canadian Cellucotton Products at Niagara Falls, Ont., for conversion into tissue grades—Kleenex, Z-Fold, Pocket Pack, Sanek, and table napkins, Fluff Wrap and Delsey; absorbent grades, Kotex and hospital wadding.

Kimberly-Clark of Canada is called a "young man's mill" because it itself is young and because most of its employees are veterans of World War II, and even younger than that.

The manufacturing debut of Kimberly-Clark on Canadian soil occurred June 22, 1945, about a year after the first forms for the concrete pilings were constructed. Kimberly-Clark's decision to build a mill at Kapuskasing was prompted by the increased demand for its products in Canada and because of the proximity to the source of certain raw materials.

Not without difficulties caused by Ontario clay, by temperature changes, and wartime priorities, the structure was built in less than a year. Reinforced concrete walls are coated on the inside with asphalt to which is applied 2-in. slabs of cork. A small air space separates these walls from the "interior" wall of common and ceramic tile.

The mill throughout was as modern as it was possible to

make it and there was room in the machine room for another creped wadding machine . . . which was in the blueprint stages within a short time.

Construction of No. 2 machine started in 1950. Stock went on the wire at 1:40 p.m. Feb. 22, 1951, and the sheet was moving over the reel at 2:51 . . . and salable wadding was manufactured that afternoon. No. 2 machine is slightly longer than its older brother, No. 1, and has a combination winder with a complete dust removal system. A 12-ft. diameter hydrapulper was installed to provide pulping of Long-Lac pulp. The former offices for mill personnel were relocated to provide extra operating space for the combination winder.

No. 2 machine was added because of the growing demand for creped wadding products that paralleled the growing industrial enterprises within Canada itself. And with Kimberly-Clark of Canada expansion of the second machine to boost production to a 70-ton capacity came an extension to the mill structure itself. The two-story extension was constructed at the north end of the mill. An extension to the trainshed also was necessary, and today the mill is 284 ft. long by 140 ft. wide and the trainshed which runs along its side is 284 by 42 ft.

Robert Gair

The company operates the following plants as divisions of Robert Gair Co., Inc.:

1. Gair Cartons Div. (mill and folding carton factory) is located on about 60 acres, owned in fee, at Piermont, N. Y., on the Hudson River with a pier to deep water, and on the main line of the Erie Railroad. This plant is located in such a good labor market that about 95% of its employees live within a radius of 10 miles of the plant. Piermont is about 20 miles from New York City, one of its principal markets, although it is able to compete, on folding boxes, over approximately the eastern third of the country. The plant comprises a boxboard mill, established in 1902, with two cylinder paperboard machines (110 and 118-in. trim), having a combined capacity of approximately 250 tons of paperboard per day and equipped for the production of all grades of folding boxboard and also Gaircote, a clay-coated boxboard. The mill is integrated with a folding carton fabricating plant equipped for the production of substantially all types of folding cartons (including egg cartons, foil-lined cartons, and folding plastic cartons). Its printing department includes the latest large letterpress equipment; presses to print in five colors and cut and crease folding carton blanks from the roll; and a sheet-fed gravure department, the only one in America for this superior quality work. The accessory equipment, cutting and creasing, stripping and gluing, is in balance with the printing departments. Gair Cartons Div. is one of the largest folding carton plants in the country with over 13 acres of floor space, and an average monthly production of approximately 3750 tons of finished folding boxes. Practically all of the production of the mill is converted by the company, chiefly in the folding carton fabricating plant at the Gair Cartons Div., but in part also at the company's Eastern States Cartons Div.

2. Tonawanda Boxboards Div. (paper mill) is located on $7\frac{1}{2}$ acres, owned in fee, at the junction of the Niagara River and the terminus of the Erie Canal at Tonawanda, N. Y. It manufactures all grades of folding and setup boxboard and also Gaircote. The major portion of the production of the mill is sold to the trade, but the mill also supplies the Cleveland Cartons Div. of the company with its requirements of paperboard and converts a small portion of its production into cigar box blanks. The plant comprises a boxboard mill, established in 1903, with two cylinder paperboard machines (96 and 120-in. trim), having a combined capacity of approximately 225 tons of paperboard per day. The plant has sidings on a branch of the New York Central Railroad, and barge facilities on the Canal. Tonawanda is only approximately 10 miles from Buffalo, N. Y., and the mill serves principally western New York and Pennsylvania, and eastern Ohio.

3. Haverhill Boxboards Div. (paper mill): Site of this mill is about 48 acres, owned in fee, on the Merrimac River at Haverhill, Mass., less than 30 miles from Boston. The plant comprises a boxboard mill, established in 1902, of approximately 6 acres of manufacturing floor space, with two cylinder paperboard machines (118 and 100-in. trim), equipped for the production of all grades of folding and setup boxboard, having a combined capacity of 265 tons per day. Almost all of the production is sold to the trade, except a small portion which is converted at the plant into cigar box blanks. It is on a division of the Boston & Maine Railroad, and its market is largely New England and New York.

4. Thames River Div. (mill and folding carton factory): Manufacturing site of this plant is about 12 acres, owned in fee, in Montville, Conn., 6 miles above New London. It is on the west bank of the broad Thames River near the course of the annual Harvard-Yale shell races. The Division also owns over 100 additional acres, largely for the protection of its fresh-water rights. The Thames River, at that point, is deep enough to permit barges of coal, pulp, and wastepaper to unload at the Division's private dock. The plant is also on the main line of the Central Vermont Railroad. The plant comprises a paperboard mill, established in 1909, with two cylinder paperboard machines (117 and 120-in. trim), equipped for the production of all grades of folding boxboard, and one fourdrinier paperboard machine (194-in. trim), equipped for the production of corrugating material for use in the manufacture of corrugated sheets for shipping containers and other products. The combined capacity of the three machines is approximately 300 tons per day. The mill is integrated with a folding carton fabricating plant, with complete modern equipment for making multicolor letterpress cartons and serves northeastern and metropolitan New York areas. Its present monthly production is about 1500 tons of folding cartons. Substantially all of the production of one of the cylinder machines, and a minor portion of the production of the other, are converted by the company into folding cartons at the plant; the major portion of the production of the second machine, chiefly special heavy duty paperboard, is sold to the trade. The production of the fourdrinier machine is substantially all consumed by the company and its subsidiary, Fibre Board Container Corp., in the fabrication of corrugated shipping containers and other corrugated paperboard products.

5. Natick Boxboards Div. (paperboard mill) is located on a tract of about 6 acres, owned in fee, at Natick, Mass., about 20 miles from Boston. This plant comprises a boxboard mill with one cylinder paperboard machine (82-in. trim) equipped for the production of setup boxboard, bending chip, and suitboxboard, having a capacity of approximately 60 tons per day. All of the production of the mill, which has a manufacturing area of about 3 acres, is sold to the trade, largely in New England. This Division has private sidings to the Boston & Albany Railroad.

6. Bogota Container Div. established about 1903 (mill and shipping container factory) is located in New Jersey, just across the Hudson River from New York. It is on the Hackensack River and on the main line of the New York, Susquehanna, and Western Railroad. The factory site comprises about $5\frac{1}{2}$ acres of land, owned in fee, and the floor area is about 5 acres. This plant comprises a paperboard mill with one cylinder paperboard machine (92-in. trim), having a capacity of approximately 100 tons per day of container liners, and a complete converting unit. Substantially all of the production of the mill is converted into solid fiber shipping containers at the plant, for which it has a 110-in. combiner. The plant also fabricates expendable paperboard pallets from corrugated paperboard made on Bogota's 63-in. corrugator.

The average monthly production of fiberboard is 5,000,000 sq. ft.

7. Eastern States Cartons Div. is a complete folding carton-making plant, located in Brooklyn, N. Y., one of the boroughs of New York City, and occupying approximately 2 acres of leased floor space, with siding on Jay St. connecting railroad in the building. This fabricating plant is equipped for the production of all the standard types of printed folding cartons. The average monthly production is about 575 tons of folding cartons.

8. Cleveland Cartons Div., Cleveland, Ohio: This is also a complete folding carton plant, in leased quarters, serving Ohio, western Pennsylvania, and New York, and points west, as far as Chicago. Boxboard is supplied largely by Gair's Tonawanda mill. The average monthly shipments of finished cartons are over 650 tons. A private siding is on the New York Central Railroad. Cleveland is a city of nearly 1,000,000 population, and is highly industrialized, and with other near-by cities, which specialize in manufacturing rubber, iron, and steel products, chemicals, pottery, automotive parts, etc., represents an active market for our product.

9. Fibre Board Container Corp. established 1915, 100% owned subsidiary of Gair System, Richmond, Va., plant: This plant is situated in Richmond, capital of the state of Virginia, with a population of 250,000—a center of the tobacco industry in the South. The requirements of this industry are an important part of the plant's business, to which is added the miscellaneous demands of Richmond and near-by cities in eastern Virginia and North Carolina. The plant is on a tract of about 3 acres, owned in fee. Its two 72-in. corrugators make approximately 19,000,000 sq. ft. of corrugated board a month which is fabricated into boxes in the corrugated box department. An exceptionally large Sheridan die press has recently been added to take care of additional display container business.

10. Martinsville, Va., in the western part of Virginia in a town of 17,000 people. In Martinsville and near-by western Virginia and North Carolina are important furniture, rayon, tobacco products manufacturers, and other industries which produce an active demand for shipping containers. This plant, together with the one at Richmond, obtains the major portion of its requirements of kraft liner board from the company's subsidiary, Southern Paperboard Corp. and the major portion of its requirements of corrugating material from the company's Thames River Div. The Martinsville plant is on a site of $3^3/_4$ acres, owned in fee. It operates one 85-in. corrugator, and its average monthly output is approximately 14,500,000 sq. ft. of corrugated board, all of which is made up into corrugated shipping containers. One specialty of the Martinsville Div. is oversize containers for furniture and mattresses.

11. Ohio Corrugated Box Div., Cleveland, Ohio, is located in the same building as the Cleveland Cartons Div., heretofore described. Its geographical market is much the same. The average approximate monthly production of the 62-in. corrugator, which is converted into shipping containers, is 8,000,000 sq. ft. of corrugated board.

12. Holyoke Corrugated Box Div. is a small service plant with no combiner. It supplies local trade in and about Holyoke, Mass., a city of 50,000. The average monthly shipping container output is approximately 50 tons. Its corrugated board requirements are supplied chiefly by Connecticut Corrugated Box Div.

13. Connecticut Corrugated Box Div. established in 1940 is in the town of Portland, Conn., population 5000, in the geographic center of Connecticut. It is across the river from Middletown, population 30,000, and near a group of important highly industrialized cities, specializing in the making, among other products, of textiles, firearms, hardware, clocks and watches, pottery, cutlery, tools, and rubber and brass products. The plant serves the State of Connecticut and western Massachusetts, a very active market. The site is about 8 acres, owned in fee, and the building has about 80,000 sq. ft. of manufacturing and office space. Private siding on the New York, New Haven & Hartford Railroad. The 84-in. combiner produces an average of 15,000,000 sq. ft. of corrugated board per month.

14. Syracuse Corrugated Box Div. established in 1926 is in Syracuse, N. Y., population 220,000, a city of many types of manufacturing activity, including small parts, clothing, paper products, business machines, salt, bicycles, etc. The plant serves also eastern and central New York State and parts of nothern Pennsylvania, an extensive and active industrial area. The property includes about 12 acres, owned in fee, and the 76-in. corrugator produces monthly approximately 13,500,000 sq. ft. of corrugated board, which is turned into corrugated shipping containers. Railroad connection, main line of the New York Central Railroad.

15. Fort Niagara Corrugated Box Div., North Tonawanda, N. Y. occupies part of a 54-acre plot, owned in fee. Although in a rural community, good steady help is readily available. The plant is near the great industrial development of varied industries including flour, radiators, aircraft, etc., in and around the Tonawanda, and Buffalo and western New York State. The plant has over 100,000 sq. ft. of manufacturing space, and is on the main line of the International Railway. The buildings are of excellent materials and modern design for efficient operation. The 78-in. corrugator produces an average of 13,500,000 sq. ft. of corrugated board a month, all of which is made into corrugated shipping containers.

16. Boston Corrugated Box Div. is located in Cambridge, Mass., on a plot of 5 acres, owned in fee. The building was built by Gair in 1947, and is handsome, modern, and efficient. Total floor area is approximately 150,000 sq. ft. The total production of the 74-in. combiner is approximately 15,250,000 sq. ft. of corrugated board monthly, and is made into boxes. The market is metropolitan Boston, eastern Massachusetts, Rhode Island, Maine, New Hampshire, and Vermont. The variety of products produced in this area and requiring shipping containers is exceptionally large—from submarine parts and fish to costume jewelry and tools.

17. Pennsylvania Corrugated Box Div. is located in a highly industrialized section of North Philadelphia, Pa., services Philadelphia, eastern Pennsylvania, southern New Jersey, Delaware, etc. Its land measures about 4 acres, owned in fee, and the buildings have approximately 75,000 sq. ft. of floor space. There is a private siding on the Pennsylvania Railroad. The average approximate output of its 72-in. corrugator is 13,500,000 sq. ft. each month and is made into corrugated shipping containers.

18. Teterboro Corrugated Box Div., Teterboro, N. J. occupies corrugated box plant building built by Gair in 1951, sold to, and now leased from John Hancock Mutual Life Insurance Co., on a lease running to 1977. The plant services metropolitan New York and northern New Jersey, an area densely populated and of the highest industrial importance. Each month approximately 16,500,000 sq. ft. of corrugated board from the plant's 85-in. corrugator is converted into boxes.

American Coating Mills

Robert Gair Co., Inc., through its purchase of the American Coating Mills Div. of the Owens-Illinois Glass Co., now serves the middle-west from the following plants:

19. Elkhart, Ind. is situated on $32^1/_2$ acres, owned in fee, in the parklike town of Elkhart, Ind., population 33,000. It is on the Elkhart River and on the main line of the New York Central. This plant is located in a good labor market, and about 95% of its personnel lives within 5 miles of the plant. The territory served by this Division includes: Cincinnati, Louisville, Milwaukee, St. Louis, and Kansas City, and, because of the nature of its products, territory even farther away. The plant comprises a boxboard mill

having two 94-in. cylinder paperboard-making machines, with an average output of about 200 tons a day, and a box shop, with 4 acres of manufacturing space, which was constructed in 1946. The boxboard produced is fully clay coated of the highest grade. The mill is integrated with the folding carton fabricating plant which is equipped for the production of substantially all types of folding cartons. From 50 to 60% of the mill's production of coated board is made into folding cartons, and the balance is sold outside. The paperboard, other than coated, used by this box shop is supplied largely from the Middletown, Ohio, plant. The pharmaceutical and cosmetic trades are large customers for the coated standard folding cartons, and for the giant folding cartons used largely for display. Noncoated board is used, in large quantities, for soft drink and beer containers and carriers, as well as the standard cartons. The box shop has complete equipment of letterpress presses, together with all necessary accessory equipment. The average monthly output of folding cartons is 1500 tons.

20. Chicago, Ill., is located on a 4-acre plot, owned in fee, in the City of Chicago, is another American Coating Mills folding carton shop, with about $2^1/_2$ acres of manufacturing space. This, too, has letterpress equipment for the printing of the cartons. The boxboard for this plant is supplied largely by Elkhart and Middletown, with some outside purchase. The average monthly output of folding cartons is 550 tons. Plant constructed in 1948.

21. Grand Rapids, Mich.: This is a small order folding carton plant, serving principally the State of Michigan. This is in quarters under lease until 1957 with a 5-year option extension. Boxboard is obtained largely from Elkhart and Middletown, and 82% of it is converted into standard lines of folding cartons, and 18% into setup boxes. The plant contains a complete letterpress printing department and accessory equipment. The average monthly production is 135 tons.

22. Middletown, Ohio, is located on approximately $5^1/_2$ acres, owned in fee. This boxboard mill, with an 82-in. cylinder machine, makes standard grades of folding and setup paperboard. The average total production is 80 tons a day, of which 35% is sold outside, and the balance to the American Coating Mills' plants at Grand Rapids, Chicago, and Elkhart.

Gair Co. Canada Ltd.

Gair Co. of Canada Ltd. operates the following plants as Divisions:

23. Campbellford, Ont., a mill for manufacturing groundwood pulp located approximately 125 miles east of Toronto on 10 acres of land, owned in fee. Producing 523 tons per month. Sold partly to Canadian users, including Gair board mills, but largely exported to the Gair factories in the United States and other users.

24. Frankford, Ont., a mill for manufacturing groundwood pulp located in the same area as the Campbellford mill, on a tract of land of approximately 80 acres, owned in fee. Producing 459 tons per month. Same market as Campbellford mill.

25. Montreal, Que.: The Montreal Paperboard Mill Div. is in Montreal. Plant is situated on 2 acres of land, partly owned in fee and partly leased. The paperboard machine is 82 in. wide and produces approximately 1500 tons per month. Manufactures some boxboard of chip grades for Gair carton factories in Toronto, Montreal, Winnipeg, and Edmonton, but mostly setup boxboard for the trade in Montreal. This is the only paperboard machine in the Montreal locality. Also manufactures jute liner board for Gair shipping container factories in Toronto and London.

26. Toronto, Ont.: The Toronto Paperboard Mill Div. is on a tract of land about 330,000 sq. ft. Land is leased from the Toronto Harbour Commission. Adjacent to the mill proper is a tract of land comprising approximately 50,000 sq. ft., owned in fee, on which is constructed the power plant. The paperboard machine has a trim of 111 in. and produces approximately 2500 tons per month. Manufactures boxboard of all grades and bottle carrier board for Gair folding carton factories and jute liner board for shipping container factories. The factory is serviced by the Canadian National Railways and the Canadian Pacific Railways. The factory is on the waterfront with harbor facilities for unloading coal supplies from boats that service the Great Lakes.

27. Toronto, Ont.: The site of Dominion Mill Div. is $16^1/_4$ acres of land leased from the Toronto Harbour Commission. Factory is on the waterfront with wharfage facilities. Mill has two machines—one machine of 102-in. trim manufactures boxboard for Gair folding carton factories which produces tonnage monthly of gypsum board for the building trade—capacity—2200 tons per month. Located in the same building is a fourdrinier machine with a trim of 76 in. for lightweight chipboard which is sold to fabricators of paperboard cans and tube stock and corrugating medium which is sold to the trade and Gair shipping container factories, capacity approximately 500 tons per month. The factory is serviced by the Canadian National Railways and the Canadian Pacific Railways.

28. Toronto, Ont.: The Corrugated Shipping Container Div. is on a tract about 93,000 sq. ft., owned in fee, and 93,000 sq. ft. leased from the Toronto Harbour Commission. This factory adjoins the Toronto Paperboard Mill Div. The company has recently completed an addition of approximately 70,000 sq. ft. The old building of about 65,000 sq. ft. is now being rehabilitated. Included in the improvements are new laboratory facilities for the Technical Control and Research Dept., of the Canadian Company as a whole. A new 85-in. corrugator to manufacture corrugated paperboard for use in shipping containers has been installed in 1953. This machine is of the latest and most modern design. This factory services the City of Toronto, east to the Montreal market and the Maritime Provinces. Average monthly production 19,000,000 sq. ft.

29. London, Ont.: This factory is located in the City of London, approximately 150 miles west of Toronto, and serves northwestern Ontario and west to the industrial cities including the automobile city of Windsor and the oil and chemical factories of Sarnia, Ont. The building, owned in fee, has 65,000 sq. ft. of floor space, and production is approximately 16,000,000 sq. ft. per month of corrugated containers.

30. Hamilton, Ont., is located on a tract of land comprising about $1^3/_4$ acres in the City of Hamilton. The land and buildings are leased on a year-to-year basis. There are approximately 16,000 sq. ft. of manufacturing floor space. Hamilton is on the western end of Lake Ontario, highly industrialized with heavy steel manufacturing and surrounded by fruit and vegetable producers in the Niagara Peninsula market. This factory does not have a corrugator but is serviced by two Container Divisions—Toronto and London—which are approximately the same distance from Hamilton. Hamilton has a monthly production of approximately 4,000,000 sq. ft.

31. Toronto, Ont., a folding carton and specialty factory on $10^1/_2$ acres of land, owned in fee, situated about 10 miles from the heart of the city, with good railway facilities on the Canadian Pacific Railway. The building is two floors and basement with adjacent storage buildings, amounting in all to approximately 200,000 sq. ft. The folding carton factory is equipped with multicolor flat letterpress printing equipment and manufactures a complete line of folding cartons. It has special folding gluers to manufacture cartons of unusual design and construction. The manufacture of bottle carriers for the soft drink trade is a substantial specialty. Capacity of the carton factory is 1700 tons per month.

In the same building is the special converting equipment for the manufacturing of asphalted papers, combined greaseproof board, combined moistureproof boards, gummed

paper tapes, cloth tapes, and corrugated wrapping materials which are sold to the trade and used in this plant. Capacity of this plant is approximately 2100 tons a year.

32. Montreal, Que.: Premier Paper Box Ltd., a wholly owned subsidiary of Gair Co. Canada Ltd., located in a 2-floor building, owned in fee, of approximately 100,000 sq. ft. This factory is in the north section of Montreal about 6 miles from the heart of the city. This subsidiary is a recent acquisition and during the past 2 or 3 years new equipment of the latest design has been purchased and installed. Modern techniques have been introduced whereby this subsidiary is capable of manufacturing folding cartons of highest quality. It services the Provinces of Quebec and the Maritimes and the capacity is 450 tons per month. Multicolor flat letterpress printing equipment and special folding gluers to manufacture specially designed cartons for the soft drink trade, shirt manufacturers, and a large volume for the cigarette trade.

Dominion Envelope & Cartons (Western) Ltd.

33. Winnipeg, Man., is located on a tract of land in the city proper comprising approximately 31,000 sq. ft., a building of 4 floors of approximately 124,000 sq. ft., owned in fee. An additional 50,000 sq. ft. of floor space is leased for storage.

This factory is the largest producer west of the Great Lakes of folding cartons, setup boxes, printed cellophane wraps, and wax papers for food products; using letterpress printing equipment, flat and rotary. Capacity 300 tons of cartons and 200 tons of paper specialties per month.

34. Winnipeg, Man.: The Adelman Paper Box Co. Ltd., a wholly owned subsidiary of Dominion Envelope & Cartons (Western) Ltd., Winnipeg. Located in the city proper. Manufactures a specialty type of high-class setup boxes and printed displays. Occupies approximately 18,000 sq. ft. of floor space in a building under lease.

35. Edmonton, Alberta, an operating Division of Dominion Envelope & Cartons (Western) Ltd., located in the city, owned in fee. Edmonton is situated on the North Saskatchewan River about 300 miles north of the United States border. The Province of Alberta is bordering the foothills of the Rocky Mountains and is rich in farm lands suitable for the grazing of cattle and producing of farm products. Located in Edmonton are large meat packing companies. Recent discoveries of oil and gas in the Province have beckoned the chemical and rayon industries. Vast sums of money are being spent in these fields. To the north of Edmonton great discoveries of uranium have been made which await the day of atomic power. This city is a great airport for air traffic to and from Asia by the northern route.

The Edmonton factory has a floor space of approximately 70,000 sq. ft. and manufactures folding cartons. Capacity is 150 tons per month, using letterpress equipment and servicing, among others, large meat packing companies. This Division also acts as selling agent for the special papers that are manufactured in Winnipeg.

Southern Paperboard Corp.

36. Port Wentworth, Ga.: Southern Paperboard Corp. operates a kraft pulp and paperboard mill, finished in 1948, located on a tract of about 120 acres, owned in fee, at Port Wentworth, Ga., about 6 miles from Savannah. The mill is equipped with a 236-in. fourdrinier kraft paperboard machine with a present board production capacity of approximately 525 tons per day. A program is currently in course of progress for further extension of the yield per cord of pulpwood in terms of board production. When this program is completed, it is estimated that the board production will be increased to approximately 625 tons a day, from the same amount of wood as used at present. The mill produces and sells, chiefly to the company and its subsidiaries and Fort Wayne Corrugated Paper Co., kraft liner board for use in manufacturing corrugated shipping containers. During the calendar year 1952 approximately 158,171 tons of kraft liner board and corrugating material and approximately 2661 tons of unbleached wood pulp were produced by the mill.

Gair Woodlands Corp.

Office, Savannah, Ga.: The function of this corporation is to supply pulpwood to the Port Wentworth mill of its parent company, Southern Paperboard Corp. Gair Woodlands Corp. owns and develops over 300,000 acres of woodlands in the states of South Carolina, Georgia, and Florida.

Consolidated W.P.&P.

In the case involving the efforts by the Federal Government to obtain forfeiture of 2100 cords of pulpwood belonging to Consolidated Water Power & Paper Co., the U. S. Circuit Court of Appeals, Chicago, handed down a decision in favor of the company and dismissed the Government claim.

The action arose out of the transportation of the pulpwood in a raft from Sugar Loaf Bay in Minnesota to Ashland, Wis., across Lake Superior, Sept. 16, 1951. The wood is valued at $35,000.

The Government sought forfeiture claiming that the tug *Rocket* was engaged in coastwide transportation in violation of maritime regulations. The *Rocket*, owned by Newaygo Timber Co., Ltd., a Canadian subsidiary of Consolidated, was registered under Canadian registry.

Consolidated contended that the *Rocket* was used in towing wood from storage booms to towing booms which was merely handling cargo prior to actual transportation by the company-owned tug *Butterfield*. The *Butterfield* was properly registered under United States registry.

The U. S. District Court, Wausau, decided for Consolidated in the Spring of 1952. The Government then appealed to the U. S. Circuit Court of Appeals, Chicago, which handed down a decision affirming the District Court and dismissing the Government claim. Consolidated's attorney in the case was T. W. Brazeau, Wisconsin Rapids.

Upper Michigan

In the rugged upper peninsula of Michigan the forests are still the major industrial potential, according to an engineering survey of the area's natural resources recently published by Ebasco Services, Inc., New York business and engineering consultants. Present profitable wood-using industries have an assured future, claims the Ebasco report, and there are great opportunities for expansion in some production fields and for new small industries.

The Ebasco study, a year-long project initiated by the Michigan Economic Development Commission, covers all natural resources of the peninsula and is designed to serve as a basis for economic development. A survey was financed by private industry, the cost shared about equally by upper peninsula and lower Michigan companies.

Among the present wood-using industries likely to remain in a healthy financial condition for years to come, Ebasco cites those engaged in the production of veneer logs, dimension stock, hemlock lumber, and pulpwood. The peninsula will not, however, support large new wood chemical plants or conventional sawlog operations, according to the study.

The brightest opportunities for expansion and new industry, declares Ebasco, lie in the manufacture of hardboard, corrugating board, small-dimension wood building material, and wooden containers; in the production of hemlock tannin extract and leached hemlock bark, and of aspen pulp for the manufacture of acetate rayon and cellulose filaments and film; and in the operation of small-log mills. These activities would be based firmly on the peninsula's extensive resources of aspen, cull, hardwood from old-growth stands, second-growth dense hardwoods, and hemlock stands.

The Ebasco report indicates that through research activi-

ties like those being carried on by the Forest Products Research Div. of the Michigan College of Mining and Technology at Houghton, new uses for the peninsula's forest harvest are likely to develop within the next few years.

Bowaters

The Westinghouse Electric Corp. will supply all electrical equipment for three log-handling gantry cranes for a new mill now under construction by Bowaters Southern Paper Corp., Calhoun, Tenn.

Regulated by full magnetic control equipment, two of the cranes will team up to reclaim wood from a new type of underwater storage system—a circular pond of 237 ft. radius in which barked logs are submerged, layer upon layer.

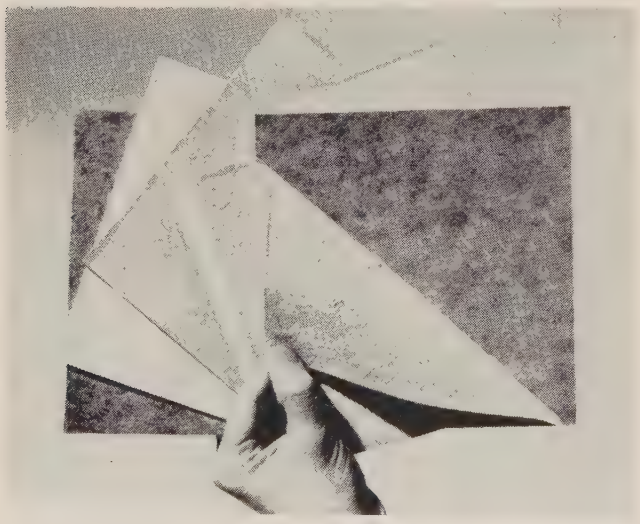
The grapple of each log-reclaiming crane will be able to handle approximately $1^1/_2$ cords of pulpwood on a 109-sec. cycle to reclaim 41 cords of wood per hour.

The third crane will be used to unload logs from rail cars, barges, and trucks. All three cranes will be built by the Link-Belt Co., Colmar, Pa.

Each crane will have one 100-hp. motor and one 40-hp. motor to power the grapple, one 40-hp. motor to power the trolley, and two $7^1/_2$-hp. motors to move the gantry. The power source will be a 440-v., 3-phase, 60-cycle, a.c. supply.

Fiberglas

Papers made of extremely fine fibers of glass are being used in a variety of industrial specialty applications, Owens-Corning Fiberglas Corp. announced recently.



Several samples of paper manufactured from glass fibers

These incombustible, inorganic industrial papers are being used for the filtration of hot and/or corrosive air, gases, and liquids. They are also finding application as base sheets in specialty electrical laminates, as gasketing material and as plate separators in aircraft and other special batteries. In such applications, the inherent high-temperature resistance and excellent electrical-chemical properties of the product are very desirable. Many other possible uses are visualized by the company but have yet to be fully explored.

Owens-Corning Fiberglas Corp. sells the fibrous glass in its wool form to the various paper companies which process the fibers and manufacture the finished paper product into the customers' requirements.

National Container

Samuel Kipnis, president of National Container Corp., has announced that the company had entered into a long-term lease covering a large tract of land and buildings formerly owned by American Car & Foundry Co. at Madison, Ill., across the river from St. Louis.

Mr. Kipnis explained that improvements will be made promptly to the property, some of which will be used in the manufacture of the company's products.

National Container now operates 19 kraft box converting plants and five kraft pulp, board, and paper mills in many parts of the country. The newest mill, the sixth, a 500-ton-per-day kraft pulp, board, and paper mill at Valdosta, Ga., is nearing completion and is expected to be in operation in the fourth quarter this year.

The Madison, Ill., tract covers 56 acres of land and 10 miles of railroad track, with five huge one-story buildings and additional smaller buildings, containing an aggregate of approximately 750,000 sq. ft. of floor space. The tract is served by the Terminal Railway Association which services all major lines coming into the St. Louis area.

Election of Robert S. Rosenfeld as vice-president of National Container Corp. of Pennsylvania, wholly owned subsidiary of National Container Corp., was announced. Mr. Rosenfeld has been in charge of the Philadelphia plant since 1947.

The Pennsylvania subsidiary has a corrugated paper shipping box plant in Philadelphia.

P.C.F.

The Board of Directors of the Penobscot Chemical Fibre Co. in June, 1952, voted to set aside a sum of $400 annually to be awarded to a son or daughter of a nonsupervisory employee of the company with the further stipulation that the winner had to go to a school that had a pulp and paper or forestry course.

The company is pleased to announce that the winner of the first Walter V. Wentworth Scholarship is Kenneth LaFlamme. Young LaFlamme is the son of Mr. and Mrs. Earl LaFlamme of Great Works, Me. Mr. LaFlamme, Sr., has worked as a millwright for the company for 38 years; young LaFlamme expects to attend the University of Maine starting this September.

Hollingsworth & Whitney

Additional manufacturing facilities have been constructed at the Mobile, Ala., paper mill of Hollingsworth andWhitney Co. by The Rust Engineering Co., Pittsburgh. One feature of this general expansion now in operation is the new multiple log conveyor system which was designed as well as constructed by Rust.

The yard section of this system, installed without interrupting normal operations and tied in with existing facilities during a two-week vacation shutdown, was redesigned to feed four barking drums instead of two without changing the original two-storage yard conveyor arrangement. The new conveyors are of heavier construction than usual and use a chain of new design.

Wearing base of the conveyor structure is of abrasion-resistant steel and conveyor troughs were given extra strength by using structural steel members rather than plate. This design allows for easier repair since a damaged member can be moved by cutting spot welds at either end.

A splitter chute was devised to effect a satisfactory division of logs at the point where each yard conveyor transfers its load concurrently to two barking drum feeder conveyors.

Arrangement of the chain differs from the usual practice in that it travels suspended in a trough below the conveyor bed. It is a single-strand type, of manganese steel, with links that are unusually thick at the articulations. Developed by American Manganese Steel Div. of American Brake Shoe

Co. for use on large log hauls on the West Coast, this installation is believed to mark the first time it has been used in a southern mill.

This type chain was also used on the chipper feed conveyors with a variable speed drive which permits maximum chipper capacity at optimum conveyor speed, and more efficient operation over a wide range of capacity.

Heavier design of the conveyor structure and chain has proved its effectiveness through added sturdiness and shock-bearing qualities, and less wear—all contributing to the system's steady operation at lower cost.

Engineering Students

Recent intense campaigns to reduce the Nation's critical shortage of engineers "are starting to pay off." Louis M. Stark, manager of the Westinghouse Electric Corp.'s school service department, recently reported that while the picture is far from bright, it is "heartening to note a 29% increase in the number of college and university freshmen who enrolled in engineering courses in 1952."

Mr. Stark spoke at an inaugural dinner at the start of a 6 weeks' Summer Fellowship Program at the Massachusetts Institute of Technology for 50 high school science teachers from 32 states. The program is sponsored by the Westinghouse Educational Foundation, which is supported by Westinghouse Electric Corp.

Emphasizing that there will continue to be a great need for more and more engineers, Mr. Stark said the most recent encouraging fact is that while enrollment on the whole moved upward 11%, engineering enrollment in 1952 jumped 29%.

"In 1951, some 40,000 freshmen enrolled in engineering and this group will produce about 22,000 graduates in 1955," he pointed out. "In 1952 the enrollment of first year engineering students rose to about 52,000, justifying an estimate of 29,000 graduates in 1956. This is still not sufficient to meet the country's basic needs, but it shows a rapid improvement."

The increase in the number of engineering freshmen last year, Mr. Stark said, is proof that the efforts of engineering societies, industries, universities, and high school science teachers have had a marked effect in steering young people into careers in technical fields. He told the high school science teachers that the role they play in increasing the Nation's engineering and man-power supply is a vital one since "the university, industry, and society at large depend on you for a continuing supply of young men and women ready to pursue a college course or productive tasks in industry."

Of primary importance, he added, is the need for high school science teachers to keep the science curriculum up to date and in keeping with the needs of society. There is also a need, in addition to modern curricula, for informed guidance and for the teaching of science as a part of general education.

Austrian F.P.L.

On July 1, 1953, Austria opened a new forest products research laboratory at Vienna and became one of the growing list of countries equipped with central institutions for this purpose. Much wood research has already been done in Austria by individual scientists working in the laboratories of different universities, but up to the present she has not had the great advantages that exist in a central institution where scientists with different specialties combine their skills in the solution of research problems. A group of scientists working together in harmony in a well-equipped laboratory can accomplish much more than when each must work by himself.

Wood is of great significance in Austrian economy and wood products constitute one of the most important factors in maintaining Austria's trade balance with other nations. Although Austria has large forests, she does not necessarily produce cheap timber, because much of it grows in mountainous regions where the cost of logging and transportation is high. The long rail or truck hauls to deep water for foreign shipment are also a cost handicap to Austrian lumber and wood products in world markets. These facts, and the necessity of keeping the annual timber cut in balance with annual growth, make it imperative for Austria to operate its wood industries with the greatest efficiency in the use of both material and labor. This situation provides the incentive for research and development in the field of wood utilization and has resulted in the decision to build a central institution for the purpose.

The Austrian Forest Products Laboratory is sponsored, managed, and supported by the Austrian Society for Wood Research. This organization is primarily an industrial rather than a governmental group, but contains in its membership and managing board, representative scientists and government officials as well as representatives from industrial firms and organizations.

The construction and equipment of the new laboratory has been greatly facilitated by ERP funds and assistance in planning and programming has been provided by F.A.O. technical assistance experts. The burden of developing plans into realities, however, has been borne by the leaders in the Austrian Society for Wood Research. The work of this laboratory with the wood-using and wood-processing industries, together with the favorable influence of the new sawmill school at Kuchl in Salzburg, will go far in helping Austrian wood industries and lumber manufacturers to make great improvements in their efficiency.

West Virginia in Brazil

As part of its investigations of the potentials of Latin America, West Virginia Pulp and Paper Co. has purchased a small integrated paperboard mill in Brazil.

The facilities, which consist of a small pulp and paperboard mill and a modern box plant, are located in Valinhos, about 40 miles west of Sao Paulo.

West Virginia gained control of the company by purchasing 100% of the outstanding stock of Ribeiro-Gerin, S. A., which founded the plant in 1943.

The South American subsidiary will be operated under the corporate title of Rigesa, S. A., which is the brand name of the products manufactured by Ribeiro-Gerin. The subsidiary will be managed by M. H. Collet, who has been in Brazil for West Virginia Pulp and Paper Co. since October, 1952. The plant will continue to be operated by the Brazilian staff presently employed.

Safety

The National Safety Council's new "Handbook of Accident Prevention for Business and Industry" is a convenient safety guide for the manager of a small business or the supervisor of a department in a large organization.

The handbook shows how to set up and maintain a safety program. Detailed information is included on subjects such as plant layouts, materials handling, housekeeping, machine guarding, electrical hazards, pressure vessel hazards, first aid, fire prevention, and personal protective equipment.

The handbook advises the small business man who cannot afford to employ a full-time safety specialist how to make use of outside assistance. Service and insurance organizations, governmental agencies, trade associations, and professional societies which can help the small operator are described.

The 94-page handbook is profusely illustrated and contains several check lists. For further information and prices, write the National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill.

NYSCF

Pilot plant research activities on pulp and paper have been authorized by the Board of Trustees of the State University of New York College of Forestry at Syracuse. Robert G. Hitchings was named project leader of pilot plant research.

The New York College proposes to provide service to industry and government agencies and to undertake group-sponsored research on paper machine, pulping, pulp refining, and related problems.

Pulp and paper pilot plant studies at the college were previously carried out beginning in 1938 when the pulp and paper laboratory was completed. During World War II, the equipment was used for the manufacture of battery separators from redwood bark. Pilot plant research has been restricted since the war because of high student enrollment and other research demands.

The pilot plant group will specialize in projects requiring the unique equipment which the college possesses in its pulp and paper laboratories. Under the new plan, any industry, institution, state, or federal agency may propose a project. If the study is within the pilot plant's scope, a contract will be made between the sponsor and the Research Foundation of the State University of New York.

Studies of radioactive isotopes for use in cellulose and polymer chemistry research will be conducted at the State University of New York College of Forestry at Syracuse. Dr. Charles H. Leigh has been named research assistant in forest chemistry to make the studies.

Appointment of Dr. Leigh, former research chemist at E. I. du Pont Co., Richmond, Va., was announced by Dean Hardy L. Shirley following a meeting of the college's board of trustees. Preliminary studies in cooperation with the Atomic Energy Commission are now being made by Dr. Leigh at the Brookhaven, L. I., laboratories of the AEC.

A 1947 B.Sc. graduate of the University of Manchester (England), Dr. Leigh received his Ph.D. degree there this year. He was a research chemist, working with radioactive materials, at Chalk River, Ont., from 1947–50.

Dr. Leigh is co-author of seven scientific articles dealing with pyrolysis of compounds and heats of formation of radicals, bond dissociation energies, and frequency factors of unimolecular reactions.

M. & O.

On May 1, maintenance crews at the Falls plant of The Minnesota & Ontario Paper Co., International Falls, Minn., congratulated themselves on a job well done, when the first run of paper in 7 weeks came off of No. 3 paper machine.

Management expressed itself as being well satisfied with the project, which was begun on March 15, and was originally scheduled to be a 9-week job. It was a remarkable achievement in view of the vast amount of work which had to be done.

The machine is now capable of producing all types of groundwood specialty papers, tub-sized groundwood sheets, and free sheet papers, such as sulphite writing and special book papers. It is now 40 ft. longer than the original machine, and has a speed range of from 200 to 1200 f.p.m.

The extra 40 ft. added to the machine gave the paper machine room a new look. A portion of the finishing room wall had to be removed to accommodate the increased length, and the dry end of the machine now projects into the finishing room. Changes were also necessary in the machine room basement, since the broke beaters had to be moved forward a comparable distance. This in turn displaced several crews of the maintenance department, who were moved to larger quarters in another part of the mill.

Much preliminary work was done on the remodeling job prior to the shutdown on March 15. This included the opening in the finishing room wall, steel bearing members for supporting the extra length of the machine, and removal of the hood over the drier section.

Even with that done, a tremendous task remained, for the machine had to be almost entirely dismantled before the rebuilding could begin.

With the machine dismantled, leaving a cavernous hole in the machine room floor, the thick concrete was chipped away from the steel supporting beams along one side, and these were moved several inches outward. With this done, and new concrete poured, the job of putting the machine back together again was on in earnest.

When it was completed, the machine length had been increased by 40 ft, most of which was due to the addition of 10 new driers—a whole new section. The smoothing presses were relocated between the first and second drier section, and facilities for tub sizing were installed between the second and third drier sections. All felt driers in the machine are now driven by felts instead of being gear driven as in the original machine. All driers are also fitted with new steam joints.

A new center-wind reel, which is more efficient than the Pope reels on the other machines, although similar in principle, takes the paper from the calender stack. A new hydraulic lift table of larger capacity and size than the old one handles the reels from the winder.

The machine is now driven by a multiple-generator electric drive, which gives synchronous push button control for all sections of the machine. A master control panel is in the basement under the machine, and each section has its own control pedestal beside it. The new drive resulted in scrapping of the old Corliss steam engine, which had a rope transmission drive. It also gave the machine its new speed range of 200 to 1200 f.p.m. The old range was restricted from 460 to 760 f.p.m. The Corliss engine had been in operation since No. 3 was originally installed in August, 1910.

Parts of the old machine were retained in the rebuilding. These included the headbox and fourdrinier section, suction couch, and suction press, which had been replaced in 1938, two drier sections, the calender stacks, and winder.

Regular Mando maintenance crews and Paul A. Laurence company men worked jointly on the remodeling project. Most of the equipment going into the machine was assembled in the plant. They were assisted by representatives of the firms which supplied the new equipment. These were from Beloit Iron Works, which supplied the new driers and other items; Midwest Fulton Co., which supplied drainage system equipment; Stamm Co., which furnished moisture control equipment; and Reliance Electric and Engineering Co., which supplied the new drive equipment.

No. 3 machine was a newsprint machine when it began operations in 1910, and continued to produce this paper until its partial remodeling in 1938. From then until its latest face lifting, it produced other types of groundwood and sulphite sheets.

Its modernization, part of Mando's program of expanding its papermaking facilities and upgrading paper products, leaves only two machines in the Falls and Fort Frances divisions which have not been rebuilt. These are No. 2 at International Falls, and No. 7 at Fort Frances.

Tall Oil in Asphalt Products

Tall oil continues to attract many manufacturers because of its possibilities for improving the usefulness of asphalt and related materials. The large volume of production and the low prices of tall oil compared to equivalent products are important considerations in the steadily expanding utilization of asphalt materials.

Tall oil is already used in appreciable amounts in a number of asphalt products and, while little has appeared on this in books or in technical periodicals, there is a growing list of patents on this art. Most developments are too recent to be found in standard works on asphalt. It is hoped that this review of information based mostly on descriptions of some of the published patents will suggest more of the numerous potentialities for combinations of these two abundant, low-cost materials.

Asphalt and related bituminous materials were in common use long before there were any chemists—or even alchemists. However, in modern times technical people have greatly in-

creased the utility of asphalt, partly by learning more about asphalt properties and partly by learning to incorporate other materials like tall oil to make asphalt more useful. The consumption of asphalt and related products is expected to increase about 10% annually over the next 5 years.

The most complete American publication on asphalt (*1*) lists about 7000 United States patents alone, with those more recent than 1941 still to be included. Most of the patents deal with products and uses. The application of tall oil to asphalt is still so new, however, that as recently as 1944, when the latest edition was written, tall oil was still being confused with other products of the wood pulp industry such as spent sulphite liquor. However, many of the numerous descriptions of processes and uses involving fatty acids and rosin are also worth careful examination for the possibilities of tall oil as a lower cost equivalent.

A number of tall oil products as well as tall oil have been found to extend the usefulness of asphalt. Tall oil pitch, tall oil rosin acids, various tall oil soluble soaps, metallic soaps and amines, as well as sulphonated, sulphurized, oxidized, and chlorinated products are to be noted.

Asphalt products are considered to include the various petroleum and coal tar bitumens as well as natural products such as gilsonite, grahamite, and many others.

Asphalt products are generally valued for their ability to withstand exposure to weather and their resistance to many chemicals. The low cost and abundance of asphalt have enabled the development of a huge and increasing market. The addition of other products to asphalt has greatly extended its usefulness by modifying some of its less desirable properties or by facilitating its application. Thus, the hardness and fusibility may be adjusted—with tall oil products, among others—as may its solubility, compatibility or fluxing with other asphalts or with resins, pitches, waxes, elastomers, or solvents. Its viscosity, adhesiveness and other properties can also be adapted to new uses by the incorporation of suitable tall oil products.

Most of the petroleum asphalt made goes into the paving of roads—70% of the 13 million tons produced in this country in 1952. Most of the rest is used for roofing products. Manufacturers of paper products and of molded products use considerable asphalt. Large quantities of natural asphalt go to manufacturers of inks, and of asphalt tile and other floor coverings. In addition there are drilling fluids, paints, adhesives, weatherproofing, and many specialties.

The usefulness of tall oil in these applications is reviewed below for the suggestions this might bring for the development of the many likely possibilities.

Roads

Asphalt roads are more popular than ever today. Nearly all new roads are paved with asphalt. Most old cement concrete roads are resurfaced with asphalt paving. Airfields also take considerable asphalt.

Even on cement concrete roads or airfields considerable asphalt is used in products for sealing joints, patching, road shoulders, soil stabilization, and the like. Tall oil enters into the composition of many of these products.

Asphalt is nearly always used in a fluid condition. In 1952, 4 million tons were used for road making as hot asphalt, 3 million as cut-back, and 2 million as emulsified asphalt. Tall oil is found especially useful in cut-back and emulsified asphalt. In addition, there are special asphalt road mixtures which tall oil has helped to establish.

In road building by the hot asphalt process the asphalt is heated till fluid and then mixed with stone and sand in heated mixers until all the stone and sand is uniformly coated with asphalt. Any wet stone or sand present is dried out in the process so that all stone and sand particles are completely coated. This results in the good bonding on cooling that is necessary for a strong asphalt concrete. The product is trucked and applied on the job while still hot. Often, however, conditions make it impractical to build roads in this way. A hot asphalt plant may not be available or it may be too remote for trucking. In such cases the job uses cold mixing on the site with cut-back asphalt.

References: (*2, 37*).

Cut-Back Asphalt

Such asphalt is made by thinning with solvents to the viscosity considered desirable for mixing. The solvents are selected so that evaporation is not serious during application. When the asphalt becomes hard again, after evaporation, the asphalt is said to be "cured." Cut-back asphalts are designated and specified by their evaporation rates as RC, MC, or SC (rapid cure, medium cure, or slow cure, respectively).

With cut-back asphalt it is often difficult to coat stone and sand adequately. Most stone and sand is naturally hydrophilic so that the surfaces prefer water and tend to repel oil. The effect is heightened when the stone and sand is exposed to the weather and allowed to soak up dew and rain. The drying of wet stone and sand before mixing with cut-back is a common sight where roads are being made or repaired. The sand and stone may be seen drying in piles over pieces of culvert pipe with fires inside.

The need to dry stone and sand is being eliminated by causing their surfaces to become hydrophobic, or water repellent, so that they prefer oil. Tall oil is being used in a number of forms as a surfactant to make stone or sand surfaces water repellent and so enable the oily cut-back film to displace the water film. A considerable art has developed around this important effect. Tall oil appears to be outstandingly effective for this surfactant use despite the trial of many other materials. Some apply the tall oil products dissolved in the cut-back asphalt. Others apply them as solutions or as powders to the stone and sand.

References: (*25, 26, 27, 39, 43, 47, 52*).

Road Emulsions

Another way of making asphalt fluid is to emulsify it with water, and tall oil products are widely used as the emulsifying agents. To obtain the desired combination of properties these emulsions are sometimes rather complicated. Various tall oil soaps are used as well as other tall oil products made by blowing, sulphurizing, sulphating, chlorinating, etc.

When the asphalt in an asphalt emulsion separates out, the emulsion is said to "break." The stability of asphalt emulsions can be varied widely and road emulsions are designated and specified as "quick break" or "slow break." Since there is no solvent to evaporate, the asphalt mix is "cured" as soon as the emulsion breaks.

The greater fluidity and rapid hardening possible with emulsions make them very useful for patching roads and other repairs.

The particle size of the emulsified asphalt, for many applications, is preferably small—below 5 microns. Tall oil soaps appear very efficient for this when used in the proper mixing machines.

References: (*5, 6, 7, 10, 12, 16, 17, 18, 22, 31, 34, 38, 45, 49, 50*).

Soil Treatments

Asphalt emulsions in a wide range of dilutions are used increasingly for many kinds of soil treatments. Many of these are still experimental but the growing need for improving our soil may be expected to lead to large demands for special asphalt emulsions.

One treatment that has been practiced for a long time calls for the dewatering of the soil to render it more solid and capable of bearing greater loads from road and building foundations. This can be done by making the soil more water repellent and tall oil products such as metallic soaps and other surfactants have proved very effective when properly applied. These water-repellent compounds, with or without emulsified

asphalt or cement, which reduce the water content of soil to about 10%, show great promise.

Such products applied to soil with good drainage also offer many possibilities for dirt roads, footpaths, and playgrounds.

Asphalt emulsions as surface dressings are also being considered for agricultural land improvements. They appear to have some of the properties of a mulch and may also prove useful for reducing wind and rain erosion. For such applications, where large quantities would be needed at a very low cost, tall oil would prove highly desirable as the emulsifier.

Asphalt emulsions are also used to protect reservoir linings, dams, river banks, irrigation ditches, and other water courses.

Asphalt emulsions incorporated during the making of adobe brick will greatly improve its resistance to water and render such brick capable of accepting oil paints.

References: (*20, 36, 42, 51*).

Drilling Fluids

The typical oil well uses thousands of dollars worth of drilling fluids during drilling. These fluids speed the drilling by cooling and lubricating the cutting heads and by floating off stone chips. The liquid also acts as a seal against the well pressure. Further, the liquid also affects the porosity and structure of the wall of the boring.

The preparation of suitable drilling fluids has become a complex art. Drilling fluids may be aqueous, they may contain emulsified asphalt and other oils, or they may be nonaqueous—a mixture of asphalt and oils.

Tall oil and its products have a number of applications in compounding drilling fluids. They are used to emulsify crude oils and asphalt-oil mixtures in water, to control the viscosity of oil-asphalt base fluids, to increase their tolerance for water, and for other adjustments in properties.

References: (*4, 9, 14, 15, 19, 21, 37*).

Paperboard Sizes

Asphalt emulsions are used in the manufacture of weather-resistant fiberboard for shipping containers and for exterior insulating boards. During World War II the now well-known V-board for boxes contained from 4 to 8% of asphalt solids applied in emulsified form as a size to the pulp. In peacetime the need for such sturdy boxes is not so general and fiberboard containing only 1 to 2% asphalt solids is considered adequate for most weather-resistant boxes. This still calls for considerable amounts of emulsified asphalt.

Tall oil as emulsifying agent gives more fluid and more stable emulsions than other fatty acids and its presence appears to improve the compatibility of asphalt blends with waxes. Tall oil pitch is also effective for this use.

References: (*3, 8, 23, 32, 35, 40, 41, 46*).

Asphalt Tile

The low cost and durability of asphalt tile have led to its extensive use—up from 40 million sq. ft. in 1937, to 400 million in 1948, and to 600 million in 1951.

Asphalt tile is formed from about 30% of thermoplastic binders—material asphalts like gilsonite, pitches, resins, waxes —and 70% of asbestos fiber, fillers, and pigment.

Tall oil and its products and tall oil pitches serve as plasticizers, as fluxing agents, and as surfactants to improve the compatibility of binder components, fiber, filler, and pigments.

References: (*29, 30, 33*).

Adhesives

Asphalt as such, or modified to improve its adhesiveness or to lessen its brittleness, is the basis of many durable adhesives. These may be in solvent solution or, for greater safety in application, in water emulsion.

Tall oil and its products are applied here as tackifiers and as emulsifying agents.

References: (*11, 13, 24, 44*).

Printing Inks

Low-cost, high-speed inks such as used for rotogravure printing are made with gilsonite or other asphalts or pitches as vehicle in suitable solvents. The solvent preferred is highly volatile, nontoxic and, of course, inexpensive. Some asphalts are not sufficiently soluble in such solvents. Tall oil products such as tall oil pitch added to some low cost asphalts of inadequate solubility will increase this to allow the making of acceptable roto inks (*28*).

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The following references include a number of patents dealing with the use of tall oil in asphalt.

The list is intended to be merely illustrative of developments in the field and the Tall Oil Association expresses no opinion with respect to their merits or those of other products and processes not listed.

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Russian Journals

The Russians are said to be easing up on their ban against exporting magazines—scientific and otherwise—from their nation. Only 180 Soviet periodicals were available in this country in 1950. During the past year, about 300 could be purchased. They are available through the Four Continent Book Corp., a Soviet agency in New York City which has a practical monopoly on all Soviet publications exported to this country.

Subscription service on many of these publications was interrupted in 1951 and 1952. Now, for some reason, such service will be resumed. Among scientific journals once more available are those in the fields of biology, mathematics, geography, geology, geophysics, physics, technical sciences, and chemistry.

However, the two main Russian journals of physics, the *Journal of Experimental and Theoretical Physics* and the *Journal of Technical Physics*, are still not exported, and no publication dealing with nuclear physics has ever been exported.

This information is reported in a recent issue of the *Bulletin of Atomic Scientists.*

St. Croix

Robert J. Hackett, former manager of the Dexter Sulphite Pulp and Paper Co. of Watertown, N. Y., which ended operations on May 30, has taken the position of sulphite superintendent of the St. Croix Paper Co., to fill the vacancy created by the resignation of Everett C. Uebrick. He has brought his wife and household goods to Woodland and is occupying the house vacated by Uebrick on Summit St.

Hackett was with the Watertown mill for 10 years, starting there as general superintendent. Born at Fort Edward, N. Y., and educated in the schools there, he graduated from the Institute of Pulp and Paper at Montreal. He has been employed by the Mersey Paper Co. of Liverpool, N. S., the Abitibi Paper Co. of Toronto, Ont., at Pine Falls, Man., and Sault Ste. Marie, Ont., and by the Algonquin Paper Co. of Ogdensburg, N. Y.

He is a member of the Masonic bodies and a Noble of the Mystic Shrine.

Combustion Engineering

Combustion Engineering has consummated a license and technical assistance agreement with Sulzer Bros., Ltd., of Winterthur, Switzerland, one of Europe's outstanding manufacturers of boilers and power plant equipment. Under this agreement, Combustion Engineering will manufacture and market "Sulzer Monotube Steam Generating Plants" which have long been built by Sulzer Bros. and of which a great many high pressure installations have been rendering satisfactory service in European countries for many years.

This agreement represents the culmination of several years' investigation of European development in the field of high steam pressures and is particularly significant at this time because of the interest in pressures above the so-called "critical pressure" of 3200 p.s.i.g. At pressures above this point the conversion of water to steam is instantaneous and skips the intermediate bubbling phase which characterizes the transition at pressures below critical. The highest pressure boiler in the world thus far is one recently placed in service by Combustion Engineering at the Kearny, N. J., power station of the Public Service Electric & Gas Co. This boiler has a design pressure of 2650 p.s.i.g., and its steam temperature of 1100°F. is also the highest used in any power station to date.

In order to achieve further appreciable gain in power station economy, it will be necessary to go much beyond the critical pressure point, and, with the special designs of boilers and turbines that this will require, it will be possible to increase steam pressures far beyond those used up to now, with steam temperatures about 100° above the present high.

The company is now prepared to build boilers for 5000 p.s.i.g. and 1200°F. steam temperature, and that still higher pressures and temperatures, are a distinct possibility. With such steam pressures and temperatures, substantial increases over the best present-day efficiencies of power generation will be attained.

H. W. Butterworth

An improved Simpson cut-off winder, for fast, economical winding of piece goods in widths to 60 in., is now being offered by H. W. Butterworth & Sons Co., of Bethayres, Pa. Mill owners report that this popular pneumatic winder saves the cost of refinishing up to 50 yd. of cloth formerly spoiled in completing one roll and beginning another. In its savings of material, time, and labor, it pays for itself each year of its operation.

The latest improvements consist in new roller bearing arms to hold the nearly completed roll and to release it automatically on completion of the winding operation, and new splicers which start each roll cleanly and smoothly, without the necessity of wetting the cloth.

The roller bearing arms receive the partially filled roll when it is transferred from the back drum to the front drum by

means of the transfer arms. When the roll has been completed and the cut made, a lever is pulled at the side of the arm and the roll drops out. No lifting of the arm is needed to release the completed roll, and the roller arm and release lever return automatically to their locked positions.

The roller bearing arms prevent the steel center bar from coming in contact with the rough iron casting of the arms. Instead, the ends of the center bar operate on the roller bearings. Wear and scarring are thus avoided.

The Simpson cut-off winder with splicers, provides the operator with an unobstructed view of the material as it comes into the machine. When the cut is about to be made, he can readily see the seam coming up and is able to cut on the seam or very close to it. For safety's sake, the operator does not come in contact with the cutting attachment, nor is he dangerously near to it.

After cutting, the new roll is started without wetting or other means of making the material adhere to the shell. Fingers on the gate feed the new end of material to the belts on the splicers. These carry the end around the new shell, assuring a clean, smooth, even wind.

The winder operates at speeds up to 200 yd. per minute and is fully automatic. In addition to its savings in material and time, it eliminates the heavy lifting formerly required of workers. Optional streamlined cover protects the machine and its operator, and is easily removed for adjustment, cleaning, or repairs.

Sveen Pederson

The Sveen Pederson Sales Co. has moved to larger quarters at 25 Jackson Ave., Long Island City, N. Y.

Du Pont

H. Thompson Latham of the Du Pont Dyes and Chemical Div. has moved from Chicago to 6451 Greenfield Dr., Cincinnati, Ohio.

The Du Pont Fabrics Div., Room 812, 350 Fifth Ave., New York, N. Y., has issued a new technical bulletin describing the properties and applications of Teflon-tetrafluoroethylene resin coated woven glass fabrics, tapes, and laminates of interest to the paper industry.

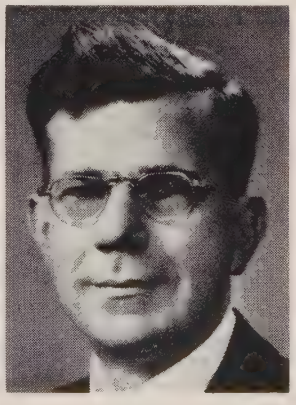
Beloit

The Beloit Iron Works, Beloit, Wis., has issued an interesting album of men and machines. It is made up of the inserts that have appeared in *Tappi*.

Hercules

Anson B. Nixon has been elected chairman of the board of the Hercules Powder Co., Wilmington, Del., succeeding Charles A. Higgins.

Mongtomery R. Budd has been named director of advertising, succeeding Theodore Marvin who resigned to become president of The Michigan Chemical Co., St. Louis, Mich.



A. B. Nixon, Hercules Powder Co.

Chas. T. Main

Chas. T. Main, Inc., Boston, Mass., has taken over the business of John A. Stevens, Inc., Lowell, Mass. The key personnel have been moved to the Boston office.

Standard Oil (Ind.)

The Standard Oil Co. of Indiana, 910 S. Michigan Ave., Chicago 80, Ill., has issued a colorful, magazine-size 32-page brochure, "Opportunities for You with Standard Oil." It is addressed to college and high school students. It tells how the company trains its workers for advancement and describes its employee benefits, such as pensions, life insurance, hospitalization, sick benefits, savings and stock bonus, vacations, and military service provisions.

General Dyestuff

J. Robert Bonnar has been appointed sales manager, Dyestuff Div. of the General Dyestuff Corp. Donald E. Marnon has been appointed manager of the Dyestuff Technical Dept.

G.E.

The Northern Commercial Co. has been appointed the first agent and distributor of General Electric apparatus products in Juneau, Ketchikan, Anchorage, Fairbanks, and Nome, Alaska. The Northerm Commercial Co. traces its history back to 1791. At that time an agreement was reached with the Russian government for the company to hunt seal near Prillof Islands. The new association with G.E. marks the compan's first venture with the major electrical equipment business.

The General Electric Co., Schenectady 5, N. Y., has issued a bulletin (G.E.A.-5995) showing the new NEMA motor standards as approved on May 19.

Black-Clawson (Shartle & Dilts)

The Black-Clawson Co. will manufacture and sell four major items of Cowles Co. stock preparation equipment on a licensing arrangement completed this week between Black-Clawson and the Cowles Co. of Cayuga, N. Y.

The products covered by the new licensing agreement include: the "Aquapulper," a unit to slush and defiber paper stock; the "Beatapulper," a combination batch pulper and refiner that slushes, defibers, and refines paper stock all in one operation; the "Classapulper," a new continuous pulper of virgin or wastepaper stock which will extract foreign materials from the pulped stock; and the "Knifemill," a refiner-type unit which will completely defiber, cut, and refine slushed paper stock in either batch or continuous systems.

These four Cowles developments are immediately available and will be built by the Shartle Bros. Machine Div. of Black-Clawson at Middletown, Ohio.

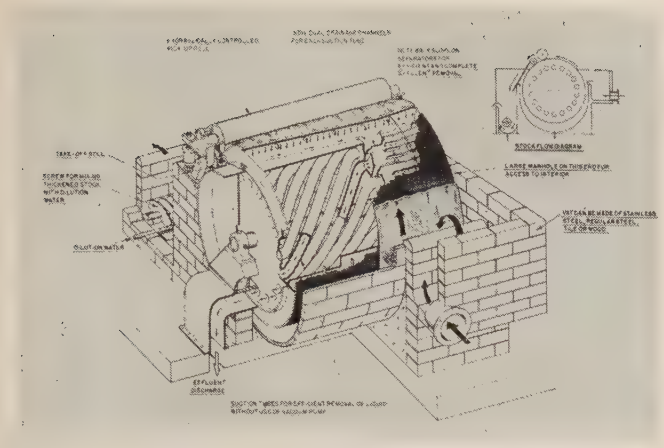
Under the licensing agreement the Shartle Div. will sell and manufacture the "Aquapulper" under the name of Hydraslusher and the "Beatapulper" under the trade name of Hydrabeater. No name changes are immediately contemplated for the Classapulper and Knifemill.

The new licensing agreement further provides exclusive rights to Black-Clawson to manufacture and sell all future Cowles Co. developments for paper mill application.

The Cowles Company has reserved the right to continue the sale of its equipment under the manufacturing agreement with Black-Clawson. The Shartle Div. will also build equipment sold by the Cowles Co.

The Black-Clawson Co. and the Cowles Co. have worked in close cooperation over the past 14 years in the development and manufacture of paper stock preparation equipment, and have in that time brought to the paper industry several outstanding machines which have helped to revolutionize the stock preparation phase of the industry. One of the most outstanding machines introduced in the past several decades is the Hydrapulper, developed through the same cooperative efforts and resulting in the installation to date of over 1250 units in paper mills the world over.

The Black-Clawson Co. has recently announced that its Shartle Brothers Machine Div. at Middletown, Ohio, will build and sell the new Shartle-Strindlund tube-type filter under licensing agreements with A. B. Ekstroms Maskinaffar of Sweden.



Strindlund tube-type filter

The Shartle-Strindlund filter is a newly designed valveless vacuum filter featuring a self-contained vacuum source. The vacuum source is built into the rotating cylinder in the form of internal water legs which eliminates the necessity of high elevation of the filter to obtain sufficient water leg. This quite naturally results in savings in building costs and horsepower previously required to elevate liquids involved.

Shartle-Strindlund tube type filter design features are illustrated in the figure, and described as follows:

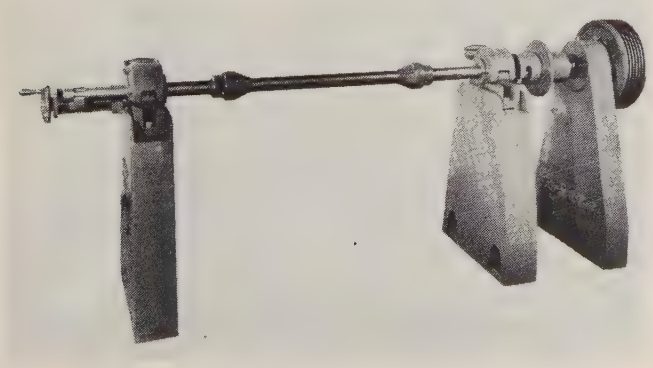
1. Radial cell walls under the winding wire which are sloped rearwardly to permit more rapid and complete cell drainage.
2. Air release tubes are incorporated to greatly increase drainage rate by allowing cells and tubes to fill more rapidly with the proper amount of liquid.

Other improvements include heavy duty rubber hose as discharge ducts which can be replaced or repaired if ever necessary because the interior of the drum is easily accessible from one end. Even the air release tubes could be replaced if ever necessary. Additionally, the bottom of the cells could be repaired from the drum's interior should a leak develop.

The Shartle-Strindlund filter is available in a complete range of sizes and capacities and can be equipped with parts necessary to make it applicable to any washing or thickening job. When consistencies of 15 to 16% are required pressure rolls can be used. When bleach or liquor washing is done showers can be added and speed adjusted accordingly.

The Shartle-Strindlund tube type filter is not limited to its uses, but can be equipped to handle practically any pulp or paper mill filtering, thickening, or washing application.

The new Dilts Model "UA" single position unwind stand features an air-actuated brake for regulating tension of unwinding webs, such as paper, board, cellophane, foil, or film. Other features include quick acting split latch type sleeve bearings and running adjustments for side lay and squaring.



Model "UA" Single position unwind with air brake

The air brake can be controlled either through a manually operated pressure regulator or through a pressure modulating device for automatic adjustment of the braking efforts as the web unwinds.

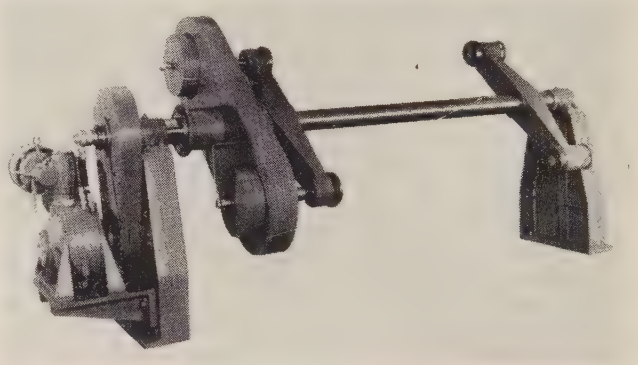
The Model "UA" single position unwind is designed and built by Dilts Machine Works Div., The Black-Clawson Co., Fulton, N. Y.

Sizes are available for a wide variety of roll diameters, widths, and duty.

Now available through Dilts Machine Works Div., The Black-Clawson Co., Fulton, N. Y., is the new Dilts Model 20 continuous two-arm winder.

This new rotatable winder can be applied to winding rolls of any suitable web material on shafts, on expanding mandrels, or directly on cores. Flying core starts can be made at speeds up to 300 fpm depending upon material being wound. After the start has been made, winding can continue at any speed suitable to the process.

Available in two model variations; the Dilts Model 20F requires a standard fixed length shaft on which cores are to be chucked, or for shaftless operation fixed length cores which can be engaged directly by spindle noses since the distance between the rotating arms is fixed. The Model 20V is adjustable to shafts or cores of different lengths. This is accomplished by moving the rotating arms in or out on the main shaft to the desired roll width.



Model 20 Continuous two-arm winder

The spindle noses rotate in ball bearings, and on the drive side are connected by means of air-operated clutches to the winding power source. On the opposite side a hand screw lock-up is provided for locking the shafts or cores. Rotation of the arms is electrically operated through a gearmotor.

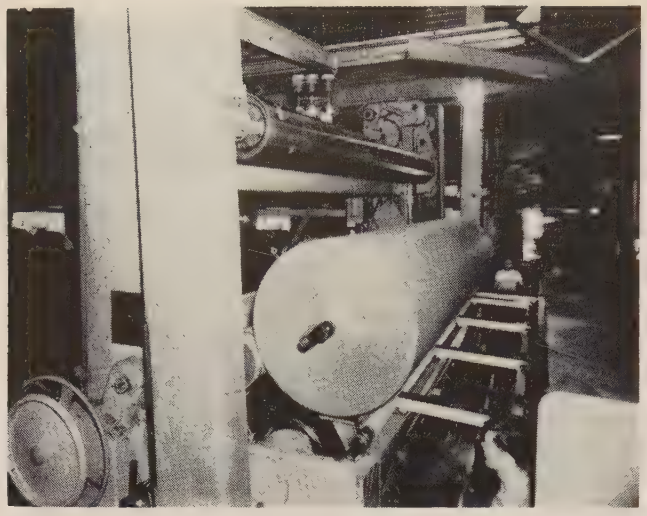
The Model 20 is available in six sizes to handle roll lengths in 6-in. increments between 36 to 66-in. face and roll diameters up to 32 in.

WESTVACO

Food Machinery & Chemical Corp. has announced that the soda ash refining facilities at Westvaco, Wyo., will reach commercial production levels on or about June 15 and deliveries will commence at that time. These facilities constitute the first wholly new soda ash manufacturing operation since 1935 by the first new producer to enter the soda ash industry since 1912. FMC's Westvaco Chemical Div. will operate the plant for the Intermountain Chemical Co. and will also act as exclusive sales agent. Both light and dense ash will be available which will meet the chemical and physical requirements of all soda ash consuming industries. This new mining and refining operation is located over a vast deposit of Trona which will provide a limitless new supply of soda ash.

CAMERON

Cameron Machine Co., Brooklyn, N. Y., has recently in-



A rewound roll being ejected from the new high speed imperial "100" winder built by Cameron Machine Co. for West Virginia Pulp & Paper Co., Charleston, S. C.

stalled one of the world's highest speed winders at West Virginia Pulp & Paper Co.'s Charleston, S. C., mill. This winder, known as the Imperial "100," has a trim width of 234 in. and a rewind capacity of 72 in. diameter. The winder is regularly running 42 and 69 lb. board at web speeds in excess of 5000 f.p.m. and has made sustained runs at 6000 f.p.m.

The Imperial "100" was designed for the production of large diameter rolls at higher rewinding speeds than had ever before been required and to have a minimum of down time between set changes.

To meet the high rewinding speed requirement, the Imperial "100" has heavy, ruggedly constructed slab type frames with the main drive gears divorced from the machine proper. This virtually eliminates vibration, even at maximum web speeds, and contributes to better strip control. The rotating cross members are all dynamically balanced for speeds up to 7000 f.p.m. and are mounted on self-aligning antifriction bearings. The main drive gears are herringbone type, straddle mounted in an enclosed box with a forced feed water-cooled lubricating system. The output shafts of this gear box are flexibly coupled to the main rotating elements. The gears and bearings are designed and manufactured with a life expectancy in excess of 100,000 hours according to accepted standards for pulp and paper machinery.

Among the features incorporated in the Imperial "100" to minimize down time between set changes are provisions for rapid adjustment and spacing of the score-cut slitting elements; power actuated rewind shaft loader and mechanism for ejecting the rewound rolls. For quick stopping between sets, and as a safety factor, the idler and compensating rolls are equipped with automatic brakes.

One of the major design improvements in this new winder at West Virginia's mill is the riding roll. This roll, while similar in purpose to those used in the past, is quite unique. It is equipped with hydraulic shock absorbers to inhibit "bouncing," and is designed to provide optimum pressure and torque distribution across the full width of the web even when running off-caliper paper. These factors contribute to the production of better rewound rolls.

In addition to the many mechanical design and operating improvements, the imperial's outward appearance is quite different. The gears, sprockets, and linkage devices are mounted on the inner side of the solid top frames, providing not only a pleasing machine to the eye, but also a completely functional design from an operating and safety standpoint.

Cyanamid

Novel household, recreational, and industrial uses for paper were demonstrated recently by American Cyanamid's Paper Chemicals Dept. in conjunction with more than 20 mills and paper goods manufacturers.

Paper bathing suits, rain caps, pillow cases, blanket covers, disposable bed pads, kitchen aprons, baby bibs, a molded paper baby carriage, duck decoys, and flower pots, auto seat covers, and molded paper apple-packing trays were among the items displayed on the outdoor terrace of the Hotel Sulgrave here. The paper products shown all had one quality in common—their strength had been increased by the addition of a melamine resin ("Melostrength Resin"). Many of the items shown are now actually available on the market; others are in the developmental or experimental stage.

Among the tests demonstrating wet strength in action and refuting the popular belief that paper must fall apart when wet were freezer pack paper that had been boiled for 72 hours without disintegration; an inch-wide strip of paper in water holding up a concrete block; and a woven paper fabric so strong that viewers were invited to wet and scour it with a steel brush. Two small fry in paper bathing suits splashed happily in a backyard tank and guests were invited to slip on a paper rain cape and hat and test their qualities under a simulated rain.

"Economy has always been an outstanding advantage of paper," John M. Walsh, manager of the Paper Chemicals Dept. of the American Cyanamid Co., declared. "Now improvement in strength, durability, and other qualities through the use of melamine resin, makes this inexpensive material, paper, available for many new uses. Greater convenience and cleanliness in the home are values that the American housewife may obtain from these advances in paper. Applications in agriculture, manufacturing, processing, and in packaging and distribution of products are extensive and varied. Melamine resin also gives other values to paper including

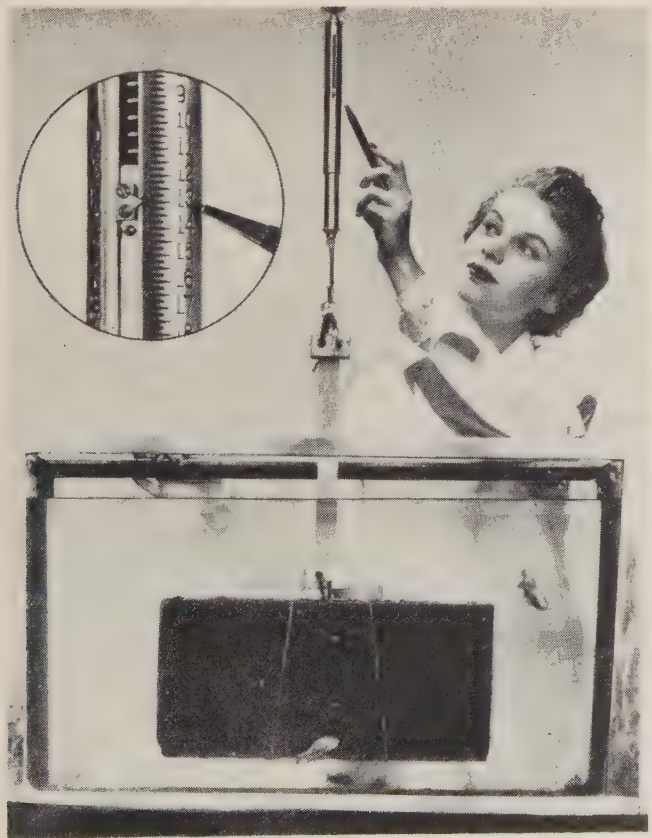
Paper bathing suits for mother and children

freedom from linting, dimensional stabilization of printing papers, and inhibition of curling tendencies in papers.

"Paper mill technology and chemical research have made great strides," Mr. Walsh continued, "but of all the new qualities of paper, we believe increased strength—wet or dry—is the most important. Scientists have known for a long time that an individual paper fiber can be as strong as a fiber of steel of the same dimensions. By the addition of melamine resin these individual fibers are tightly bound together, thus providing a practical way to make paper and paper products stronger than ever before. To help meet consumer demand for these new and improved paper goods, American Cyanamid Co. will fully cooperate in providing the paper industry with technical information and service based on the latest research findings."

The demonstration was the first public showing of the broad application of melamine resin to consumer paper products. The original discovery was made at the Stamford Research Laboratories of American Cyanamid Co. in 1942 when it was found that the addition of synthetic melamine resin to paper pulp could as much as double the dry strength over the untreated paper, and increase its strength when wet by as much as five times over the untreated paper. This laboratory discovery was made available to the Armed Forces and the National Bureau of Standards. The melamine resin proved so effective when used in map paper that resin-treated combat maps were able to withstand a series of savage tests including a map being nailed to the floor of an Army mess hall and exposed to the trampling boots of a regiment of men. Since that time, melamine resin treatment has been standard for Army maps for combat use. The melamine resin treatment was also used in the manufacture of so-called V board paper containers that had to withstand unloading on beaches without giving way to water and spray.

After the war, Melostrength resin was made available for tests in civilian products. More than two million tons of papers of many grades and types were treated with melamine resin in what was probably the most thorough use-test ever conducted. Towels that withstand vigorous rubbing, potato bags that hold together during shipment across the country, ice cube bags that won't give way even when the ice melts, and lintless windshield wiping papers that won't disintegrate are among the most common consumer products. Other widespread uses where this wet-strength paper has been extensively tested include blueprint paper, photosensitive papers, butchers' papers, frozen food packaging, dental bibs, industrial wiping papers, and laundry and cleaners' tags.



Block of concrete suspended by strip of paper that has been treated with Melostrength resin

"These extensive consumer tests have been highly favorable," Mr. Walsh said. "Now we are moving to identify Melostrength resin-treated products by use of a trade name. A quality control inspection program will help to insure high standards of wet strength. However, there are dozens of other factors that go to make good papers, and the brand name of the paper mill or paper products manufacturer will continue to be vital as a guarantee of quality along with the resin."

Among the paper mills and paper goods' manufacturers participating were: Hollingsworth & Vose Co., Hurlbut Paper Co., International Paper Co., Keyes Fiber Co., Marathon Corp., Mosinee Paper Mills Co., Rhinelander Paper Co., Reigel Paper Corp., Rieser Co., Inc., St. Regis Paper Co., Seaman Paper Co., and Sterling Pulp and Paper Co.

Also: Acorn Paper Co., Allen Quimby Veneer Co., Animal Trap Co. of America, Eastman Kodak Co., Frank & Sayford Co., General Cellulose Co., Inc., Graham Manufacturing Co., Inc., Hawley Products Co., Hubbs & Howe Co. (Sani-Tread Div.), and Marlan Corp.

Melostrength resin is made from the synthetic chemical compound, melamine. (Melamine, first synthesized in 1830, is a complex chemical compound made from coal, lime, air, and water.) Melostrength resin is similar to the resin used as a finish on textiles to impart dimensional stabilization and wrinkle resistance. Used in paper it increases both dry and wet tensile strength and bursting strength. It also controls linting and increases the "pick" resistance of printing papers, particularly important in the case of offset papers, since fibers of paper may tend to lift from the surface of the paper during printing.

The resin is shipped to the paper mill as a dry powder which can be stored indefinitely. Mixed with a very dilute solution of acid, the resulting mixture is added in small percentage to the paper pulp during the beating or mixing process. It acts quickly to help bond the paper fibers together, and by the time the paper comes off the machine most of the strengthening action of the resin has taken place.

Another unique quality of the resin is that the resin added to paper pulp reduces the necessary beating time. Reduction in beating time of pulp not only means some saving in power costs, but it produces a sheet of paper with better dimensional stability and less tendency to curl, improvements particularly desired in printing papers.

This resin also has the unique advantage over other chemicals that have been used to improve the strength of paper in that it has a high degree of resistance to acid hydrolysis.

The following companies cooperated in preparing the exhibit:

Marlan Corp. of New York together with Laurel Fabric Co. of Scranton, manufacture and distribute yard goods from Melostrength resin-treated twisting paper. The yard goods are then woven into open or closed fiber fabrics in colorful or subdued designs for use in making auto seat covers, trunk liners, beach and sports wear, table place mats, floor mats, and beach hats. Trunk lining on display is currently being used by Chrysler in manufacture of the 1953 Plymouth and Dodge and automobiles also by Kaiser-Frasier, Studebaker, and Hudson.

Hurlbut Paper Co. situated in the Berkshire at South Lee,

Mass., have been paper manufacturers for almost 150 years. Their resin-treated "saturating" paper shown on display is used in the manufacture of table tops, counter tops, cabinet work, and their "saturating" paper is an absorbent paper made stronger, wet or dry, by the presence of Melostrength resin. In the manufacture of finished products such as table tops the paper is printed, then impregnated with a plastic material, then cut into sheets, placed one on top of the other and pressed together at high temperature. The resin gives absorbent "saturating" paper needed strength to be pulled through impregnating baths, insuring a fast, economical operation.

Seaman Paper Co. of Otter River, Mass., are manufacturers of high content Melostrength resin-treated towelling stock and industrial all-purpose papers. This grade of paper is shipped in jumbo rolls to mills, such as Graham Manufacturing Co., Inc., who convert the paper for industrial and window wiping purposes.

Graham Manufacturing Co. in Holyoke, Mass., convert towelling grade paper containing Melostrength resin into industrial wiping papers, window and windshield wiping papers, all sold under the trade name "GRACO." Made stronger, wet or dry, these disposable lint-free papers are ideal for cleaning precision instruments, for wiping radar screens, automobile windshields, house windows, and mirrors.

Animal Trap Co. of America with headquarters in Lititz, Pa., are manufacturers of molded pulp flower pots treated with Melostrength resin. Hospitals have insisted upon use of these pots for delivery to patients. The resin-treated molded pulp holds together under the effects of damp or wet soil. When the plant has expired, the entire pot and soil can be sanitarily disposed of. Made of molded pulp, there is no danger of sharp edges being created as a result of rough or careless handling.

Bay West Paper Co. of Green Bay, Wis., manufactures industrial towelling from bleached and unbleached kraft paper treated with Melostrength resin and supplied by Mosinee Paper Mills Co. Trim-Towels and Prep-Towels are two of the trade names under which Bay West sells its towelling made stronger, wet or dry, with the resin.

Hawley Products Co. of St. Charles, Ill., convert cellulosic fiber treated with Melostrength resin into tropical hats, accoustical sound absorbers, typewriter cases, and projector cases. Most unusual among the resin treated products, however, is a full size baby carriage molded from treated pulp. Finished products made by Hawley Products Co. have been adopted by the aviation, automotive, radio, television, and packing industries, to name a few.

Mosinee Paper Mills Co. in Mosinee, Wis., are manufacturers of several grades of paper among which is industrial towelling stock and windshield wipers. The bleached and unbleached kraft paper is treated with Melostrength resin and the finished sheet as a jumbo roll is then sent to a converter, Bay West Paper Co., a Division of Mosinee, located at Green Bay, Wis., where the finished towelling is made and packaged.

Sutherland Refiners

Lionel Sutherland of the Sutherland Refiner Corp., Trenton, N. J., has just returned from an extended tour of European papermaking facilities, which included visits to paper mills in England, France, Italy, and Finland, and discussions with paper executives in a number of other mills.

Mr. Sutherland made interesting observations on European papermaking practices. For example, in England and France the great majority of mills are not integrated, or only partly so. The English mills depend largely on Scandinavian pulps for their operations. He also noted that on the continent a number of mills were operating combination machines, where the wet end was composed of both fourdrinier and cylinder sections. These were used in various combinations, and at times only one or the other section was being utilized.

He also noted that considerably more labor was utilized in the average European mill than is the case in the United States, and that primarily this is due to the low cost of labor and the relatively high cost of power and equipment. In some cases, particularly Italy, discharging an unsatisfactory employee is a difficult and lengthy procedure, and once hired the employee can work, even at common labor, until he is 70 or 75 years of age. In addition, the paper mills in Italy are required by the government to employ a minimum of 11% of disabled persons. This seems to be working out very well in the mills, as there are many jobs which the disabled worker can perform thoroughly satisfactorily and thus his productivity and usefulness to society are realized.

Another point noted was the high degree of land usage, especially in northern Italy. However, on the continent as a whole the large population and the demand for food prevents the development of large resources of pulpwood. For this reason most European countries, with the exception of the Scandinavian countries, rely on imported pulps. However, many mills in France and Italy are utilizing wood from the Alps and Yugoslavia to supplement the available fibers such as wastepaper, straw, and esparto, as well as the Scandinavian pulps. In France, a fairly bright hardwood pulp was being made from chips which had previously been extracted for tannin.

In short, the basic difference noted between United States and European mills is that European mills are generally much smaller. They depend to a large degree on imported fibers and use labor to a much greater extent than conditions would permit in the United States. Chiefly this latter difference is due to the relatively low wage rates in Europe and the high cost of mechanization, plus the fact that it is difficult to displace labor with equipment unless some suitable opening exists to absorb the excess employees.

During his visit to Finland, Mr. Sutherland was impressed by the fine stands of pine existing in the Eastern portion of Finland, as well as by the modern paper mills which he visited there. Since the war, the Finnish paper companies have tended to manufacture more of their pulp into paper and to export the finished paper rather than concentrating on making and selling pulp in the export market. The Finnish mills have an adequate supply of pulpwood and reasonably adequate power resources, which permit their operation to be more nearly on our standards than most other European mills. The paper and wood industries are the largest in Finland, making up nearly a third of their total employment.

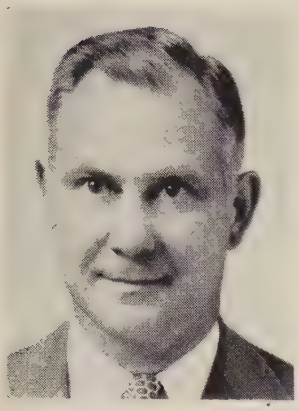
In England, Mr. Sutherland visited Thames Board Mills, the Mersey mill of the Bowater Co., and the Aylesford mill of Albert E. Reed Co. All three of these plants are large and modern but depend largely upon imported pulps for their virgin cellulosic materials.

Mr. Sutherland also visited Walmsley Ltd. at Bury, Lancashire, England, and Officine Meccaniche Poccardi Pinerolo at Pinerolo, Italy, where Sutherland refiners are manufactured. The plant of O.M.P.P., about 30 miles from Turin, is a modern, well-operated machine shop and the workmanship seen here was of excellent quality.

Railroads abroad, although generally, if not always, government owned, operated very closely to schedule, and the equipment as a rule compared favorably with U. S. trains, excepting some of our modern streamliners. Dining car service was in a series of sittings, usually three, and the main course was limited to a choice of one or two items instead of the wide selection available on the hotel and restaurant menus.

Food supplies were adequate in the hotels and restaurants, although prices were rather high in the larger cities even when compared to U. S. prices. However, in the smaller cities and towns prices were quite reasonable.

The language difficulty was not a serious problem, because many Europeans speak three and four languages. Today many people study English or learn it as a valuable business



L. M. Sutherland, Sutherland Refiner Corp.

J. E. Atchison, Parsons & Whittemore, Inc.

asset, and they are always eager to practice, so an American speaking a foreign language might not have much opportunity to use it. For example, in the airport in Copenhagen, flight departures were announced in English, French, Danish, and German.

One of the problems experienced was in connection with foreign exchange, and it was at times a problem to remember the dollar equivalent of French francs, Swiss francs, lire, florins, Finn marks, and especially the pounds, shillings, and pence system used in England.

JOHNS-MANVILLE

William S. Hough has been appointed manager of the Chicago District of the Industrial Products Div. of the Johns-Manville Corp.

PERKINS-GOODWIN

William H. Anders is rejoining Perkins-Goodwin Co., New York, N. Y., as vice-president and director. Mr. Anders was recently vice-president of the St. Regis Sales Corp. in charge of the Nashua River Paper Div. at East Pepperell, Mass.

PARSONS & WHITTEMORE

Joseph E. Atchison, formerly of Porto Rican Paper Products, Inc., and the Economic Cooperation Administration, has joined the executive staff of Parsons & Whittemore, Inc.

MOVIDYN

The United States Movidyn Corp., Chicago, Ill., has entered the pulp and paper industry market with its slime-controlling product, designated as A-36.

ARCCO

American Resinous Chemicals Corp., Peabody, Mass., has issued a data sheet (A-44) on its emulsion adhesive ARCCO-1294-31L, a wet stick adhesive.

AMERICAN POLYMER

Morell Marean has been appointed sales manager of the American Polymer Corp., Peabody, Mass. The company has recovered from the recent explosion in its plant and is completing a large addition to its plant.

Dow

Thomas M. Gow has been named supervisor of plastics sales in the Cleveland, Ohio, area of the Dow Chemical Co. He is succeeded at Midland, Mich., by M. H. P. Morand.

COLUMBIA-SOUTHERN

The Columbia-Southern Chemical Corp., 420 Fort Duquesne Blvd., Pittsburgh 27, Pa., has issued a 24-page brochure outlining the use of Pittchlor for water, sewage treatment, and general sanitation purposes.

MORNINGSTAR, NICOL

Morningstar, Nicol, Inc., New York, N. Y., has been appointed exclusive distributors to the paper trade of the new Pabst Brewing Co. starch converting enzyme called Amizyme. This product is described as an alpha amylase and produces liquefaction or dextrination of starch.

MOORE & WHITE

The Orton Corp., Fitchburg, Mass., has been appointed New England sales representative for the Moore & White Co., Philadelphia, Pa., manufacturers of papermaking machinery.

CHEMICAL SHOW

The Exposition of Chemical Industries, held in New York annually since 1915 will be held in the Convention Hall, Philadelphia, Pa., on Nov. 30 to Dec. 5, 1953.

EBASCO

E. K. Wilkins has been appointed general construction manager of Ebasco Services, Inc., New York, N. Y. In his capacity Mr. Westcott will supervise all Ebasco construction activities.

FOOD MACHINERY

Alfred T. Loeffler has been appointed assistant vice-president of the Chemical Divisions of Food Machinery and Chemical Corp., New York, N. Y. Mr. Loeffler was formerly with Hooker Electrochemical Co. and Monsanto Chemical Co.

ROOTS-CONNERSVILLE

Ralph R. Newquist has been appointed president and general manager of the Roots-Connersville Blower Div. of Dresser Industries, Inc., Connersille, Ohio. Mr. Newquist was formerly with the Allis-Chalmers Mfg. Co.

HOOKER

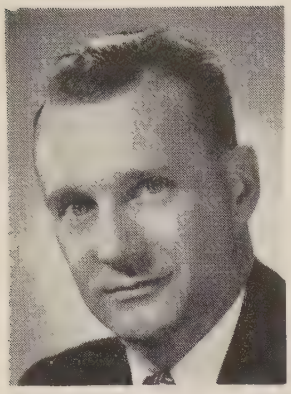
John T. Walmsley has been promoted to the Chicago and midwest area as a salesman for the Hooker Electrochemical Co. He is located at 1 North LaSalle St., Chicago, Ill.

Marble-Nye Co., Worcester, Mass., has been purchased by Hooker. The New England firm will continue to operate under its own name as a Hooker subsidiary. Marble-Nye has for many years represented Hooker, Penick & Ford, Diamond Alkali Co., American Potash & Chemical Co., Axton-Cross Corp., and the Rumford Chemical Co.

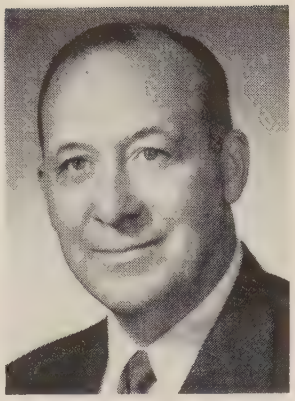
MASON-NEILAN

Alex M. Thackara has been appointed Los Angeles, Calif., district manager of the Mason-Neilan Regulator Co., at its new headquarters 2822 E. Olympic Blvd.

The new Los Angeles office of the Mason-Neilan Regulator Co.



R. S. Magruder, Sprout, Waldron & Co., Inc.



C. H. Vickery, E. D. Jones & Sons, Inc.

National Starch

National Starch Products, Inc., 270 Madison Ave., New York 16, N. Y., has announced two new products. Resyn-3100 a fast setting resyn-type emulsion for use as a seam adhesive on satchel bottom bags, of special interest to manufacturers of flour bags. A new vinyl-type hot melt adhesive called Book-Lok-63R for use in book binding where it has permitted increased production speed from 80 to 300 books a minute.

Magnuson Products

Magnuson Products Corp., 50 Court St., Brooklyn 2, N. Y., has issued a new booklet on Permag cleaning compounds for paper mills.

Link-Belt

Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill., has issued a new booklet on Roller Chain Wheels Available from Stock with Taper Bushings (Book 2449).

Titanium Pigment

Earl W. Diener has been appointed Eastern sales manager of the Titanium Pigment Corp., 111 Broadway, New York 6, N. Y., filling the vacancy left by the untimely death of John A. Lutz.

B & O

Joseph L. Stanton has been appointed assistant director of public relations of the Baltimore & Ohio Railroad, Baltimore, Md.

Hobbs

Hobbs Manufacturing Co., Worcester 5, Mass., has issued two new folders on the New Hobbs Automatic Production Cutter and its "Strong" Semiautomatic Label Cutter. Copies may be obtained from F. J. Woodberry, assistant sales manager, Dept. N 288, 26 Salisbury St., Worcester 5, Mass.

Sprout-Waldron

Robert S. Magruder has been appointed a salesman for Sprout, Waldron & Co., Muncy, Pa. Mr. Magruder is a 1939 graduate of the N.Y.S.C.F., and was formerly with St. Regis at Deferiet, N. Y., and the Paper Corp. of America at Cheybogan, Mich.

Pennsalt

Harry G. Smallens has joined the Technical Service Dept. of the Pennsylvania Salt Mfg. Co., Philadelphia, Pa., as customer consultant on hydrogen peroxide bleaching. He was formerly with Becco in Buffalo.

The Corrosion Engineering Dept., Pennsalt Chemicals, 1000 Widener Bldg., Philadelphia 7, Pa., has issued a new chart which shows the corrosion resistance of cement to 297 chemicals.

Huber

J. M. Huber, Ink Div., 626 Sixty-second St., Brooklyn 20, N. Y., issues a very interesting monthly magazine called *Huber News*. The June issue featured the newspaper industry, the April issue featured phonograph records, and included a sample record of "Stars and Strips Forever." The August issue features the Champion Paper & Fibre Co.

Westinghouse

Westinghouse Electric Corp. has broken ground for its new research center in Pittsburgh.

E. D. Jones

Charles H. Vickery has been promoted to the position of vice-president in charge of sales of E. D. Jones & Sons Co., Pittsfield, Mass. He has been sales manager since 1947.

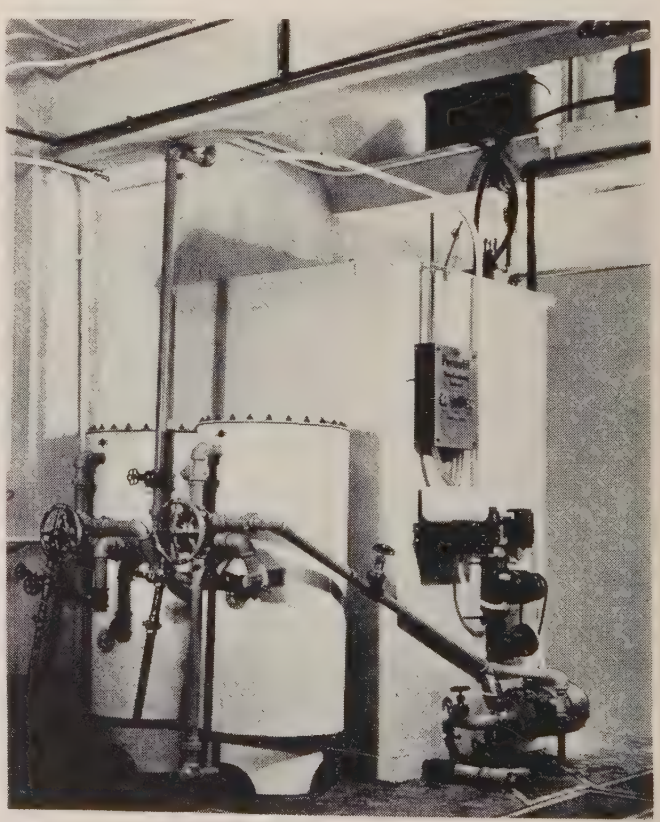
Ingersoll-Rand

Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y., has issued a new bulletin (Form 7226) on its line of horizontal, single-stage and vertical, multistage fire pumps.

Permutit

The Permutit Co., 330 W. 42nd St., New York 36, N. Y., has issued a new 12-page bulletin (2508) on Permutit Ion Exchangers for water treatment.

Permutit now manufactures a package water conditioner in capacities from 500 to 3300 gal. per. hr. The units may be used to remove turbidity, color, and organic matter from water supplies; to chlorinate; to remove bad tastes and odors; to remove iron in manganese; to neutralize; to soften; and to dealkalize.



Package water conditioner now manufactured by Permutit

ALLIS-CHALMERS

The Allis-Chalmers Mfg. Co., 838 S. 70th St., Milwaukee, Wis., has issued several new and interesting bulletins: 1952 Annual Review of New Equipment; Proper Maintenance of Control (14 x 7612A); A-C Rocking Contact Voltage Regulator leaflet (14B 6B 7A); American Jet Tray Deaerator for Power Plants (Type K-114-28R 7980); A-C Process Pumps (52B6651C); and A-C Size 0-3 Alternating Current Across the Line Motor Status (14B 7132A).

DOW CORNING

The Dow Corning Corp., Midland, Mich., has issued two new and interesting bulletins "Tall Tales and Fabulous Facts" featuring the tenth anniversary of the company and its products. A data sheet (8-100) on Dow Corning XS-1 features the water-soluble silicone which imparts water repellency to paper products.

LOUIS ALLIS

The Louis Allis Co., Milwaukee 7, Wis., has issued a new bulletin (1250) covering its line of "Hollow and Solid Shaft Vertical Pump Motors."

MERRIMAC

Philip L. Slayton has been named branch manager of the Chicago territory of the Merrimac Div. of the Monsanto Chemical Co. Associated with him will be Daniel P. Shedd.

OBITUARIES

Fred C. Boyce

Fred Comstock Boyce, 84, chairman of the Board of Directors, D. J. Murray Manufacturing Co., Wausau, Wis., and a retired paper mill executive, died June 28 in the Milwaukee Hospital, following a stroke of paralysis on June 21. Funeral services were held June 30 in Milwaukee with interment in the Wisconsin Memorial Park, where Masonic rites were conducted.

Mr. Boyce was widely known throughout the paper industry, and particularly as the "father" of the American Pulp & Paper Mill Superintendents Association. He presided at its organization meeting in 1919 when he was unanimously elected to the presidency, an office he held through 1921.

On the fun side of papermaking, Mr. Boyce founded another organization known as the "Ancient Order of Chinese Paper Makers," the membership card of which is engraved with mystifying Chinese characters, attesting to the Chinese invention of the papermaking process many centuries ago.

Born in Wilton, Saratoga County, N. Y., Feb. 2, 1869, Mr. Boyce located in Wausau in 1905 as production manager of the Wausau Paper Mills Co. in Brokaw, continuing in that capacity until 1935, when he retired from active papermaking, although his interest in papermaking continued throughout his life. He started work with the Hudson River Pulp & Paper Co., afterwards known as the Hudson River Mill of the International Paper Co. located in Corinth, N. Y. He was with them for 19 years. In 1901 he located in Oconto Falls as general superintendent of the Falls Manufacturing Co.

In addition to his activity with the D. J. Murray Manufacturing Co. he was vice-president of the Wisconsin Paper Products Co., Milwaukee, a paper wholesaler concern, and a Boyce development.

In addition to his business interests, Mr. Boyce was active in Masonic lodge work and on May, 1953, was honored as a 60-year member of the Masonic fraternity. He was chairman of the Board of Trustees of the First Methodist Church for 12 years, served as a delegate to the Wisconsin Conference of the Methodist Church and to the United Conference of the Methodist Church of the United States, and served as delegate to the National Council of the YMCA. He was also affiliated with various movements of that organization. On July 19 the administration building at Camp Manitowish that was presented to the YMCA by Mr. and Mrs. Boyce was dedicated.

Surviving are his widow; two daughters, Miss Edith Boyce and Mrs. Gertrude Boyce Bergman, Milwaukee; two sons, Fred C. Boyce, Jr., and Curtis Boyce, Wauwatosa, Wis.; six grandchildren and five great grandchildren.

Gerard H. Lafontaine

Gerard H. Lafontaine, paper technologist, Howard Smith Paper Mills, Ltd., Montreal, P. Q., died in his sleep on July 1, 1953, at Westmount, P. Q.

Mr. Lafontaine was born in Montreal on July 13, 1896, and graduated from McGill University in 1920. Since graduation he was employed as a chemist by the Rolland Paper Co., Riordon Pulp & Paper Co., Brompton Pulp & Paper Co., Roessler & Hasslacher Co., Bennett Ltd., and the Howard Smith Paper Mills.

Robert D. Moynihan

Robert D. Moynihan died suddenly on July 9, 1953, at Glens Falls, N. Y.

Mr. Moynihan was bleach plant and stock preparation superintendent for Finch, Pruyn & Co., Inc., Glens Falls, N. Y.

He was born in Glens Falls on July 27, 1905, and was a graduate of the Glens Falls High School.

For 13 years he was employed by the Research Division of the Engineering Dept. of the International Paper Co., at Glens Falls, following which he was technical director of Finch, Pruyn & Co., and for the past six years was superintendent.

Funeral services were held at Glens Falls on July 13.

LETTERS TO THE EDITOR

Photoelectric Instruments for Measurements of Color

To the Editor, *Tappi:*

The theoretical study of color and the instrumentation of color measurement are unfortunately sufficiently complex

that only a relatively few highly trained technical men can devote the time necessary to become competent in the field. It is to such technical specialists that the management, operational, and technical staffs of all industries must look for design evaluation and recommendations as to the present state of utility of colorimeters, spectrophotometers, and allied equipment for practical industrial color measurement.

For several years, The Institute of Paper Chemistry has been serving as the technical specialists in color measurement for the paper industry, publishing information on studies of various photoelectric instruments for color measurement. Institute reports on photoelectric instruments lead to certain conclusions by their authors. Inasmuch as some of these conclusions (specifically as relates to the Color-Eye (*1*) report) are not based on test procedures recommended by the manufacturer, or are at variance with the considered opinions of highly competent color authorities, it is believed only fair to colorimeter manufacturers in general, and to those in industry who must make decisions on the practical use of colorimeters, to point out such differences of opinion. Use of colorimeters for impossible tasks will only react to the detriment of the broad program of industrial instrumentation; on the other hand, failure to make practical use of colorimeters for the tasks they can adequately perform may impair an industry's relative competitive position.

Centralized evaluation of new instruments for industry is a sensible and valuable procedure. However, conclusions officially resulting from such studies must be consistently sound and reliable, failing which, they may mislead the thinking of the industry for a considerable period of time before being negated or corrected by competent authority.

Industry is concerned with color measurement in fundamentally different functional operations: (1) laboratory work and (2) production color control. Both spectrophotometers and modern photoelectric colorimeters are potent laboratory tools. High sensitivity colorimeters are also valuable instruments for production color control when properly applied.

In industrial color measurement, two main categories of measurement problems arise: (1) The accurate establishment of "absolute" color of standards in ICI space. (2) Comparison or difference colorimetry wherein colored samples are measured against colored standards. This is the only type of measurement that can be made visually, and is the only practical present method of instrumental measurement where the darker commercial colors must be measured to within human eye tolerances.

Establishment of "absolute" color is a job for the spectrophotometer, and even then it is a tough laboratory task to measure the darker colors within an error less than eye tolerance. This statement will be substantiated in a later paragraph.

The place of comparison colorimetry in industry may best be stated by reference to works of Deane B. Judd of the National Bureau of Standards, perhaps the most outstanding and respected practical authority on color in the world. Mr. Judd, in "Color in Business, Science, and Industry (*2*) says:

"Modern photoelectric spectrophotometers have greatly extended the application of both visual and photoelectric colorimetry. They have supplied a rapid, practical way to calibrate working standards of color. If a fairly large group of specimens is at hand to be measured, say 20 or more, all of similar spectral composition, the most satisfactory way to measure them in the present state of colorimetric science is to evaluate one or two of them carefully by means of the spectrophotometer to serve as working standards, then obtain the color specifications of the rest by visual or photoelectric determination of the difference between specimen and standard. Note how many factory color control problems fall in this category. Variations in manufactured goods come about from small changes in the proportions of a small number of colorants, or from variations in the manufacturing process such as temperature, humidity, acidity, alkalinity, or from minor variations in the colors of raw materials. It is rare that any such influences introduce importantly metameric differences between successively produced goods.

"Another important application of colorimetry by difference from a spectrally similar standard is the solution of such problems as the color changes produced by various deteriorative agents (weathering, heat, salt spray, acid, alkali, abrasion, and so on), or those produced by admixture of a colorant, or toner. In these problems, the color standard is the original unexposed or untoned specimen; and the chief concern is to evaluate the character and amount of the color differences, the absolute evaluation of the colors being of secondary interest, or required only approximately. For these applications colorimetry by difference would be used in preference to indirect colorimetry by means of the spectrophotometer because it is quicker and cheaper."

Colorimeters *are now* valuable tools for industry when properly used. This is certainly not the impression left by the IPC papers. Perhaps a brief discussion of certain points in those papers, with particular reference to the report on Color-Eye, will permit the readers of *Tappi* to better judge whether or not colorimeters should be used in their industrial control problems.

Point 1—Colorimetry by Difference

As indicated by Mr. Judd, the correct method of using a filter colorimeter is for *difference* measurements. There are several basic reasons for this:

1. In order to duplicate the amazing sensitivity and accommodation of the eye, unattainable instrumental accuracy would be required unless measurements were made on a difference or ratio basis. The eye is logarithmic—no linear instrument can currently compete with a logarithmic device, including the spectrophotometer, when the darker commercial colors are involved. (A major percentage of commercial colors are in the "dark" region noted herein.)

2. It is physically impossible to obtain optical glasses and photocell surfaces that will precisely duplicate the average observer, and no "plea for photometric accuracy" will solve that problem. Colorimeter manufacturers do a sound engineering job of reasonably matching the theoretical curves. For colorimetery against a white standard, such "photometric inaccuracy" will result in errors in *absolute* color space; for practical colorimetric measurement by difference (sample against colored standard of similar spectral composition), absolute shape of the filter curve (so-called photometric inaccuracy) is of negligible importance.

3. Color measurements are made to satisfy the human eye. The eye always makes measurements on a difference basis, and all eyes do not have identical "filter curves." If photometric *accuracy* was required to compare colors of similar spectral composition, our eyes would cause us considerable difficulty.

Although evaluating colorimeters designed specifically for comparison or difference measurements, and with both instrument manufacturers and other color authorities endorsing the difference method as the proper use of filter colorimeters, the IPC reports show no evaluation of Color-Eye (or other instruments) by the difference method. Great stress is also laid on "photometric inaccuracy" of filter colorimeters in these reports by using them for absolute measurements when competent color authorities do not *expect* a filter colorimeter to provide absolute color data to a high degree of accuracy.

Stable filter colorimeters will make measurements against white with good *precision*, that is, with ability to give the same value over long periods of time, even if somewhat in error on an absolute basis. This is an important feature for two reasons: (1) It permits sufficiently accurate positioning of a colored standard in color space to permit evaluation of the size of allowable visual tolerances (*3*). (2) It provides a means of checking drift of standards subject to change with time, and for reasonable drifts, permits compensation therefor so that original color can be maintained.

In other words, even with the theoretical inability to completely match desired filter curves, the colorimeter can usefully

measure against white standards. This utility is paying off daily for industrial users of colorimeters.

Point 2—Spectrophotometric Inference

Throughout the IPC reports, spectrophotometric measurements are treated as correct, *per se*. This can be most misleading to persons not skilled in the art. The spectrophotometer is a very precise and well-designed instrument, but each instrument and its operator have unavoidable inherent errors. The writers do not feel competent to estimate the errors in the IPC spectrophotometer, but do wish to offer data to indicate that errors may be appreciable and that the inference that the spectrophotometer is correct and any instrument disagreeing therewith in error is most misleading.

Errors in the spectrophotometer increase as reflectance decreases. However, even at higher reflectances, assumption of 0.001 maximum errors in x and y is subjected to severe question. In a paper before the Optical Society in 1952, I. Nimeroff of the Bureau of Standards discussed "Propagation of Errors in Spectrophotometric Colorimetry" (*4*). The essence of his work is shown in Fig. 1 for a 10% reflectance sample. This figure shows in the x, y color plane, the uncertainty of spectrophotometric measurements (solid ellipses) compared with MacAdam's ellipse showin minimum visual perceptibility of difference (both 10× scale). It will be seen that the spectrophotometric errors are comparable to eye tolerance and far in excess of 0.001 error in x and y for most colors.

In another series of tests, sets of polished glass tiles were tested by several capable laboratories using spectrophotometers on an absolute basis (as recommended by IPC) and colorimeters on a difference basis (as recommended by other authorities) against a calibrated standard. Measurements on *a single tile* are plotted in Fig. 2, with circles representing four spectrophotometers and crosses representing six colorimeters. These tiles are below 5% reflectance, emphasizing the spectrophotometric error. However, an appreciable percentage of industrial color, and particularly the difficult colors, are in this region.

A second illustration of the potential error in spectrophotometric measurements on dark colors was given by Rudick and Ingle (*5*) at the Spring, 1953, meeting of the Optical Society. In the case of a color of reflectances 3% (X = 3.20, Y = 3.00, Z = 2.80), differences in the absolute values of X, Y, Z of 0.1% which is believed to be the normal accuracy limit of a well-operated spectrophotometer, result in visual differences in MacAdam units (*5*) as follows:

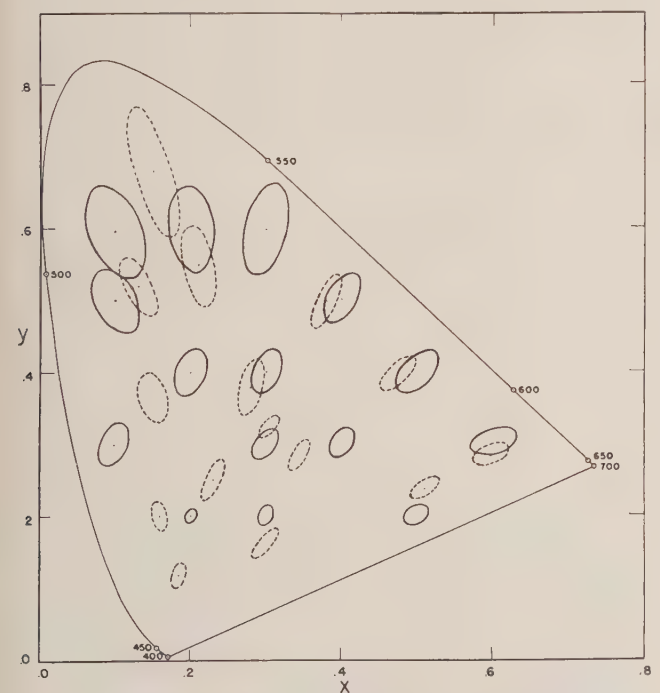


Fig. 1. Uncertainty ellipses compared with MacAdam perceptibility ellipses for the spectrophotometer. Correlated uncertainty, solid line ellipses; MacAdam perceptibility, dotted line ellipses. (All ellipses are plotted on a × 10 scale)

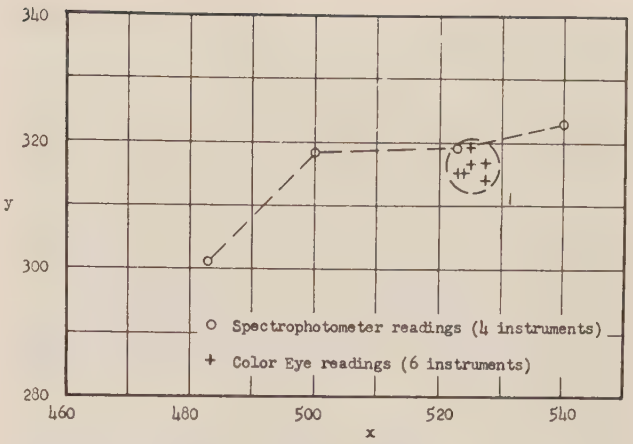


Fig. 2. Comparative measurements by four spectrophotometers and six Color-Eye instruments on a single polished glass tile of low reflectance

X, %	Y, %	Z, %	*MacAdam units*[a]
±0.1	...	...	7.6
...	±0.1	...	8.7
...	...	±0.1	2.7
+0.1	+0.1	...	4.0
−0.1	+0.1	0	7.4
+0.1	+0.1	+0.1	3.3
+0.1	+0.1	−0.1	5.9
−0.1	+0.1	−0.1	17.0
...	+0.1	+0.1	8.7
...	+0.1	−0.1	10.1
+0.1	...	+0.1	7.1
+0.1	...	−0.1	7.5

[a] For those not familiar with MacAdam units, one unit approximates the minimum visually perceptible magnitude of color difference.

On logarithmic colorimeters measuring this color, differences would be recorded as nearer 3% than 0.1%, with corresponding greater precision of difference measurement. (Colorimeters would read X/X, Y/Y, Z/Z.)

Accurate calibration of standards by spectrophotometers requires very careful use of the instrument plus statistical procedures to reduce the residual error.

Summarizing, the inference by the IPC that the spectrophotometer is correct by definition is misleading, and work of other competent men in the field indicates spectrophotometric errors in colorimetry may be appreciable in medium reflectances, and excessive in the lower, but industrially important reflectances, when differences of normal visual tolerances are involved.

Point 3—Metamerism

Great emphasis is placed by the IPC on metamerism. This paper is not directed only to technical specialists in color who are probably quite familiar with the points made herein, so a definition of metamerism is in order before discussing it.

The true spectrophotometric curve of a sample is the basis for the definition of its color. To fully evaluate color, this curve must be combined with the spectral curve of the illuminant and the sensory perceptor curves of the eye.

If two samples have identical spectrophotometric curves, they will change absolute color as the illuminant or observer

changes, but *they will always match one another under any illuminant and to any observer.*

In industrial coloring, due to variables in dyes, raw materials, and processing, the true spectrophotometric curves of successive samples may differ somewhat. However, when a specific illuminant such as a particular color of daylight is concerned, it may be possible to obtain an apparent color match for a particular observer. If either the illuminant or the observer are sufficiently changed, the samples will mismatch. Such samples are called *metameric.* If *near* metamers, then appreciable changes in illuminant or observer will be required to produce mismatch; if *badly* metameric, individual observers will disagree under a single illuminant, or small changes in illuminant will seriously affect their judgment.

Filter colorimeters cannot reliably measure bad metamers. However, neither can human observers from a practical standpoint. The writers are not technical experts in the paper industry, but it is hard to believe that the paper problem is appreciably different than that of the textile, paint, plastics, and other industries. In those industries, color procedures leading to metamerism are avoided because they only lead to trouble in visual matching. Many times, such avoidance is not accomplished knowingly, a dye or procedure merely being abandoned because of too much customer difficulty with matches.

Whether a colorimeter or the human eye is used, any industry should strive to intelligently avoid metamerism to reduce costly arguments. On near-metamers which do occur in normal processing, colorimeters can do and are doing a satisfactory job.

To again quote Mr. Judd "in general, satisfactory accuracy can be expected from such photoelectric tristimulus colorimeters for the determination of small color differences between nonmetameric pairs. And even for measurement of fairly sizable nonmetameric color differences . . . and small chromaticity differences with a moderate metameric component . . . the discrepancy is in the neighborhood of 0.002 in x and y which is negligible for many purposes."

Colorimeters should *not* knowingly be used for highly metameric pairs. A very common case of this sort is the original match to a standard of unknown coloring agents. In such cases, customer approval of a new standard in your own colorants is the only sensible procedure whether an instrument or the eye is to be used for production control.

Summarizing, it is the opinion of the writers that undue emphasis is laid on metamerism in the paper industry by the IPC reports and that, where severe metamerism actually does exist, important savings in color losses could be made by concerted efforts to reduce industrial metamerism even where human matchers are used.

Point 4—Effect of Heat

The IPC report refers to the effect of sphere heat on paper samples and on Vitrolite standards. Color-Eye manufacturers will agree that heat in the sphere causes temperature rise to about 130 to 140°F., which changes the color of *some* materials either temporarily or permanently. This condition is currently being eliminated by use of a lamp cooling system originally developed by the Monsanto Chemical Co., Plastics Div.

As for Vitrolite fading due to heat, no correlation for the IPC report can be found. The procedure of solarizing Vitrolite standards for stabilizing is open to question. As one authority puts it, "why ruin good standards by exposure to sunlight they never need see."

Point 5—Conditions of Illumination and Viewing

Color of a material is not only a function of color of the illuminant, but also of the condition of illumination and viewing. As shown by recent studies, the average condition selected by the human observer is a combination of direct and diffuse illumination and usually at varying angles. No two instrument types completely duplicate conditions of illumination and viewing, nor do they agree with conditions selected by a particular observer.

Such variations have some effect on difference measurements, but more important effects on comparisons of absolute measurements on two different instruments. Not only did the IPC compare absolute measurements on the spectrophotometer and Color-Eye, each having different viewing and illumination conditions, but they partially included the gloss or "specular component" in spectrophotometric measurements and excluded the gloss on Color-Eye.

Summarizing, the IPC evaluation is based on lack of agreement between two instruments, measuring on an *absolute* basis, under noticeably different conditions of measurement. It is, therefore, open to serious question as to whether the instruments should agree within the error magnitudes involved.

Some Other General Comments

Apart from specific points, there are other general comments that should be included to complete this discussion.

Realizing that many paper mills generate their own power, a word of explanation is in order on the frequency dependence of calibration (but *not* zero) of Color-Eye, a matter on which both IPC and the manufacturer agree. Color-Eye is frequency dependent *only* because the commercial voltage regulator normally supplied is frequency dependent. Where frequency varies, an electronic regular can be furnished, eliminating this difficulty at some increase in cost.

Most public utility supplies are so well regulated frequency-wise as to cause no trouble.

Linearity of the slit mechanism is noted as "serious." The slit is mechanically linear, and was recognized at the time of design as optically slightly nonlinear; that is, the percentage reduction in light by the slit motion is not exactly proportional to mechanical slit motion. The slit was designed to give *reproducible*, not precisely linear data. For difference colorimetry the slit linearity never enters the picture. When the slit is used, the manufacturer lays no claim to being able to agree with the spectrophotometer on an absolute basis. It is not only unnecessary in comparison colorimetry or checking drift of standards, but why worry about small slit nonlinearity when conditions of illumination and viewing between various instruments and the human observer disagree so widely?

As far as time dependence on photometric accuracy is concerned due to dust and dirt, Color-Eye was designed with *minimum* number of optical surfaces, and all are dust sealed so as to minimize effects of dust. Lenses are ground integral with prisms for the same reason. In fact, the optics of Color-Eye have less surfaces for dust accumulation than the spectrophotometer. Criticism of the dust situation is a case of theoretical criticism of an instrument rather than of the question as to whether the manufacturer has recognized the theoretical problems and done a sensible design job to reduce the effects.

Possible yellowing of the sphere paint is mentioned. This is a theoretical possibility. Far more important is the fact that the instrument manufacturer specially developed a stable, cleanable sphere paint so that the practical operator did not have to smoke spheres with magnesium oxide. For comparison measurement, slight yellowing is secondary. In any case, much greater errors result from accumulation of colored lint on one side of the sphere—an error to which the spectrophotometer is equally liable. Occasional "blowing" out of the sphere as called for in maintenance instructions avoids this difficulty.

Use was made of dye solutions for checking of the instrument, with measurements on an absolute basis. Trans-

mission samples may exhibit very steep spectral curves, emphasizing filter errors on an absolute basis. The best answer to this error study is that at least one concern is using Color-Eye as a transmission continuous dye-o-meter with excellent results—they are working *with* the instrument and saving dollars by finding what it *will* do, not what it won't.

The conclusion that Color-Eye is not sufficiently accurate to be used as a means for obtaining ICI data (page 152A) (on an absolute basis) is superfluous. It was never intended to be. Color-Eye was designed to *compare colors* with primary filters reasonably simulating ICI primaries.

As far as eye sensitivity is concerned, the eye is an amazingly sensitive instrument. However, the eye can *detect* differences smaller than it can readily *define* in direction of error. The most important factor in which the eye is weak is that of quantitivity. A colorimeter can put numbers on the extent of difference—the eye cannot evaluate differences numerically with accuracy and reliability.

Summary and Recommendations

Centralized industrial agencies for careful test and evaluation of new equipment are highly desirable. However, it should be appreciated that those who depend on such centralized evaluation on complex instrumentation cannot, by and large, be specialists in the subjects concerned. It is, therefore, essential that both test and reporting procedures be carefully reviewed so that data are factually reported in a manner not misleading to the nontechnical reader.

It is also urged that the manufacturer of equipment under test be extended the opportunity to comment on planned test procedures and review the test reports. Report review should not be with any intention of modifying sound conclusions whether or not they be favorable, but to give the testing activity an opportunity to consider any comments the manufacturer may have *before* publication rather than afterward. If an erroneous opinion is published, the damage done is very difficult to undo.

Finally, it is suggested that evaluation agencies such as the IPC review instruments so as to fairly answer three broad questions: (1) What can the device do *for* the industry? (2) Are there tests which users of the instrument might expect of it that it cannot accomplish satisfactorily? (3) What other uses are considered possible, but not sufficiently evaluated to permit rendering a sound opinion as to applicability?

To paraphrase a slogan of one industrial concern—"It is better business to utilize instruments of good commercial performance today than to wait indefinitely for perfection." For maximum utility, evaluation studies should point out how good instruments *can* be used today.

INSTRUMENT DEVELOPMENT LABORATORIES, INC.
Needham Heights, Mass.

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3. Rudick and Ingle, "A Comparison of the MacAdam and the Adams-Nickerson Indexes of Color Differences," Paper No. 66, Spring Meeting of the Optical Society of America.
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5. Rudick and Ingle, Optical Society paper.

To the Editor, *Tappi:*

The discussion by the Instrument Development Laboratories, Inc. (whom we shall refer to for convenience as IDL) is relative to Report No. 17 to The American Paper and Pulp Association, Part X, on the "Color-Eye," a three-filter photoelectric colorimeter developed by the Glass Division Research Laboratories of the Pittsburgh Plate Glass Co. and IDL, and manufactured by the latter company. This report was sumitted to APPA on Jan. 28, 1952, and copies were sent to IDL; subsequently it appeared as Instrumentation Studies LXXVI in the November, 1952, issue of *Tappi*. It seems desirable, before discussing the detailed remarks by IDL, to make some comments on the instrumentation program. This program is supported and controlled by APPA through its Technical Committee, and the major portion of the work has been done in the laboratories of The Institute of Paper Chemistry. The aims and philosophy of the program have been set forth in several publications (*2–6*). Put very briefly, the chief aim of the program is to assist the pulp and paper industry to obtain and to achieve better instruments and instrumental methods for the evaluation and control of all paper properties. As a scientific agency for the work of the program, the Institute has no prejudice toward any instrument, or instrument company, and no financial interest in any such company. However, the Institute is aware of the impact of its instrumentation work on the commercial distribution of instruments and, hence, has always attempted to be objective and factual in the planning, execution, and reporting of instrumentation studies. As evidence of the fairness of the program we offer the fact that in the more than 18-year history of the investigations there has not—until now—been a serious criticism of the work or of its reporting, either in the form of a published note, or in correspondence. In the past the reactions of instrument manufacturers have been constructive, and the reported findings have been utilized in the making of improvements in their devices.

An ill-founded perfectionism in the instrumentation program would be intolerable to the users and builders of instruments alike. It would be easy for a research laboratory to slip into perfectionism in the form of unreasonable and unnecessary demands on accuracy and performance of instruments; being aware of this and being in almost constant touch with the men of the paper industry and their problems, the Institute staff constantly strives to exercise good judgment.

The men for whom the instrumentation work is done and the reports are written are the technical men of the pulp and paper industry. (It is highly doubtful that instruments are purchased by administrative personnel on the basis of what they may read in the instrumentation reports.) There is a long history of photoelectric color evaluation in the paper industry (some of the old-timers will recall the pioneering work of Hatch, Davis, Lewis, Hauff, Green, and others). Because of this and the importance of accurate color measurement and control in the paper industry, there are hundreds of technical men in the industry who have regular contact with the control of color by means of photoelectric reflection meters, spectrophotometers, and three-filter colorimeters, and most of these men have more than a nodding acquaintance with the CIE (or ICI as most of us tend by habit to refer to it) system of color specification. Over the years educational meetings and symposia on color measurement have been sponsored by the Institute and by TAPPI, both nationally and locally. The technical men of the industry prefer the basic, analytical approach in the instrumentation studies. From data obtained with this approach they can infer much more about the probable performance of an instrument than would be possible were the studies limited to measurements made only in accordance with the instructions of the instrument makers (this is not to say that such instructions should be ignored). For example, these men are well aware of the difference between the techniques of evaluation by absolute and comparative measurements; they know from data on absolute accuracy what kind of performance is to be expected in comparative measurements *and in applications of an instrument not covered or anticipated by the instrument manufacturer's literature.* If an instrument manufacturer admits that his device is valid only for comparative measurements of a cer-

tain ill-defined class, such limitation of claim should not preclude a searching investigation of the variables and performance of the instrument.

One more remark of a general nature should be made. The authors of the communication from IDL state (with regard to metamerism), "The writers are not technical experts in the paper industry, but it is hard to believe that the paper problem is appreciably different than that of the textile, paint, plastics, and other industries." We can only say that we wish that the writers of the IDL "critique" were correct in their belief that color problems in the paper industry are not appreciably different from those of other industries! There are, in fact, some very notable differences. It would be fatuous of us to ignore or to belittle the problems of other industries; however, the production of some industries is essentially that of batch operation. Well-controlled ingredients are mixed in vats or reaction vessels under carefully controlled conditions of temperature and pressure. The operations of a pulp and paper mill are exceedingly ramified and complex; there are literally hundreds of important variables, not all of which are easy to control, and there are specifications to be met on many properties of the paper, some of which are mutually antagonistic. The production of paper is continuous, although there are batch operations along the line, and a single run may amount to hundreds of tons. It is most unfortunate if a single run of paper is rejected because of failure to meet specifications on color, which are often very exacting. For the reasons set forth in more detail later in this reply, small color differences are much more readily seen in paper than in most other products. A symptom of this fact is the existence of a grade structure, for certain papers, in which "brightness" (a technical, not colorimetric optical property) ranges over a total of only 3% for a whole grade of paper; another commercial symptom is the fact that the cost of elevating the brightness of pulp by 1% is of the order of 1 or 2 dollars per ton.

Before commenting on the specific points raised by IDL in their discussion, it is requested that readers seriously interested in this matter read, or reread, the instrumentation report on the Color-Eye (*1*).

In the second paragraph of their communication, IDL claim that some of our conclusions are not based on test procedures recommended by the manufacturer or are at variance with the considered opinions of highly competent color authorities. The first point is covered in the above introductory comments, except that we should say that the manufacturer's recommended test procedures (especially as they relate to *color difference* measurements rather than absolute measurements) really were in mind and were taken into account. We seriously doubt that color authorities would disagree with our principal conclusions if they studied some of the rudimentary aspects of color matching and color control in the paper industry and analyzed our data from the point of view of use of the Color-Eye in a typical paper mill. One of the world's most outstanding men in the field of colorimetry wrote from England, several months prior to the receipt by TAPPI of the IDL discussion, saying (relative to our recent reports on photoelectric colorimeters) that he entirely endorses our comments about the average kind of three-filter colorimeter; he added that he thought the exhaustive tests which we have described are "admirable," and he wished that they were more widely applied. However, argument by authority rather than by analysis of the specific matters at issue is objectionable from a technical standpoint, and such argument is invidious.

We object to the implication that the instrumentation studies or the conclusions presented in them are "official" in any way. The results of the studies are presented to the industry, for the industry to use in any way it sees fit. If we ever find that we have misled the thinking of the industry, we will be among the first to correct the condition; we have made errors in the past, and we have been quick to correct them.

The quotation from Judd's "Color in Business, Science and Industry" is plausible, and probably applies effectively to certain industries. In our opinion, the quotation does not apply to the paper industry; we are quite sure that it does not apply to the use of the Color-Eye (of the model studied) in the paper industry.

About 17 years ago we joined others in accepting the plausibility of the statement that, if one is comparing materials of similar spectral composition, and if the color difference is small, a filter colorimeter which does not quite fit the theoretical demands might be good enough reliably to indicate the nature and magnitude of a color difference. A number of experiences convinced us of the incorrectness of this view where the paper industry is concerned. References to analytical discussions of this matter are given at the end of the report on the Color-Eye (*1*). Many words can be saved by requesting the reader to study the report, with particular reference to the introductory paragraph and to the last section of the report, entitled "Performance of the Color-Eye in Color Matching." *We request the reader to treat the data in a manner appropriate to the method of evaluation by color difference, as thoroughly discussed in the paragraphs under "Measurement of Color Differences" (1).*

The matter of metamerism in the paper industry is very important to the present discussion. It is, unfortunately, a technical subject which is difficult to handle in an analytical way without the use of integration or demonstrations with actual instrumental data, as in our report on the Color-Eye. Metamerism in color matching is discussed in the report in the second introductory paragraph, and in the section on color matching. We are here not necessarily concerned with the obvious metamerism corresponding to a great change in visual color difference on changing the illuminant from tungsten lamp to daylight; we are also concerned with a technical metamerism in which the spectral reflectance curves for two papers whose colors are nearly the same criss-cross in such manner and in such regions that, if a filter colorimeter does not have spectral response similar to that of typical normal observers, its indications of color difference will not always agree with the color differences seen by normal observers. (For example, if matches are made with the Color-Eye, there would be important instances in which normal observers would see easily noticeable color differences; or, if the Color-Eye were used to check the beater men, there would be important instances when matches or close matches would be pronounced by the Color-Eye as objectionable mismatches.) This technical metamerism in the paper industry has magnitude depending on many factors; in some mills the control of variables may be such that metamerism only occasionally becomes strong (but let one not ignore these cases, because they are individually important), whereas in more typical situations the variability of the optical and physical properties of the pulps, of beating and refining, of additives, of the mill water, of the screening operation, of the fines content of the white water, and of the many variables of the wet end, pressing section, and drier part of the paper machine gives rise to sufficient technical metamerism that an instrument like the Color-Eye will not indicate color matches and color differences with adequate reliability. A fair idea of the extremes in metamerism that can cause trouble in the use of a filter colorimeter are found in the data presented in Table VI of the report (*1*) and Figs. 13, 15, and 16 (medium to strong metamerism) and Fig. 18 (weak metamerism). Even in the case of weak metamerism (on which the data were very carefully handled by different methods) the error in indication of the Color-Eye, *calculated in a manner appropriate to color difference measurement,* was found to be 0.0037—which is large enough to lead to argument and difficulty in the mill. The IDL discussion admits that the Color-Eye is not

sufficiently accurate to handle cases in which strong metamerism is present because of the use, e.g., of dyes different from those in the sample to be matched. The fact that strong metamerism is frequently encountered in paper mills is not to be denied; nor should it be denied (by those knowing human nature) that color men would attempt to use the Color-Eye in all kinds of situations, including those in which the metamerism is strong. Who would tell these people when the degree of metamerism is now weak enough for the colorimeter to yield reliable data, and now strong enough to lead to trouble?

We regret as much as anyone the preparation of a negative instrumentation report (although the report under discussion is definitely not all negative, as several excellent features of the Color-Eye are clearly brought out). To some, a negative report blocks progress ("some measure is better than none"—a common but uncritical remark). As discussed earlier, if a negative report is founded on perfectionism, the situation would be very objectionable. However, as a result of long contact with instrumentation in general, and photoelectric color measurement in particular, the technical men of the pulp and paper industry are very cautious. It should be said with emphasis that instrumentation has suffered severe setbacks in the past because of poor methods and instruments of measurement. It is, therefore, in the interest of the long-range advance of instrumentation that the studies should be thorough and judiciously critical.

It may be that a major percentage of colors of industry generally are in the "dark" region and it may be that the Color-Eye is effective in this region; we did not examine this. In the paper industry itself, however, the major tonnages of paper are in the "white," tinted, and intermediate ranges. Much of the strongly colored paper incorporates relatively large amounts of dye, but such paper should not necessarily be classified as having color in the "dark" region.

With regard to the several comments made by IDL under "Colorimetry by Difference," we feel that what we have said in the foregoing and in the report on the Color-Eye are sufficient. It does seem desirable to point out, in connection with the matching and control of "white" papers—which, of course, should be regarded as colored—that anybody in the paper industry with long experience in the use of reflection meters for the control of white papers would consider with reservation the claims of IDL with regard to the *precision* of the Color-Eye. Quite apart from the matter of suitability of the spectral response of the Color-Eye, there are the following very important variables of *any* photoelectric reflection meter: photometric scale errors, centroid or effective wavelength of any light source-filter-optical system-phototube combination, and geometrical factors. These variables have occupied our close daily attention, in connection with well-designed instruments used for the control of *white papers*, for a period of 19 years at the Institute alone. We know that troublesome variations (greater than 0.3%, roughly) in the reflectance of white papers and pulps can be quantitatively associated with the foregoing variables. This is an old story to many men in the industry who have employed such instruments as the General Electric reflection meter, the Hunter multipurpose reflection meter, the Photovolt reflection meter, and other photoelectric devices. These and similar considerations were in mind when certain instrumental variables of the Color-Eye were investigated, such as dependence on line frequency, dependence on line voltage, linearity (of the photometric system), temperature of the sphere and fading of standards, and influence of aging on color temperature and sphere constant.

After long experience with recording spectrophotometers we are quite aware of the sources of error in spectrophotometry; all of our instrumentation studies involving the G.E. (Hardy) recording spectrophotometer have been planned and carried out with these errors well in mind. The most serious errors are those which become important *when the data from different laboratories are compared* (there are several sources of just sufficient magnitude to warrant discussion, the most important single source of discrepancy being in the ultimate standard of reflectance). In our studies, everything is planned from the point of view of internal consistency, and the results of the studies are especially valid when applied to the analysis of an instrument designed for *color difference* measurement. When it is found that such an instrument is in error by an amount corresponding to a discrepancy on the CIE diagram of the order of 0.003, it is ludicrous to hold that a substantial portion of the error is attributable to error in the use of the recording spectrophotometer when (1) the same specimen areas are measured on the two instruments at about the same time, (2) the standardization and operation of the spectrophotometer are effected in accordance with the best principles of internal consistency (e.g., use of the same standard for two specimens, undisturbed use of the same chart paper, prevalence of the same instrumental constants and of the same photometric and wavelength corrections), and (3) the recording spectrophotometer is operated at *maximum sensitivity* and at reduced speed. Under these conditions, we have calculated that the error pertinent to color difference measurements owing to uncertainties in the operation of the recording spectrophotometer is of the order of 0.0005. This is in sharp contrast with the IDL statement that "However, even at higher reflectances, assumption of 0.001 maximum errors in x and y is subject to severe question." The whole point is that the segmental errors on the CIE diagram, calculated in a manner appropriate to *color difference* measurement, for the Color-Eye are often very large compared to the uncertainty originating in defective precision of the spectrophotometer.

In further regard to the accuracy of the Color-Eye in the measurement of *color differences*, the IDL discussion ignores the analysis of the discrepancies presented in our report; it is clearly shown how the discrepancies may be explained in terms of the defects in the spectral response of the Color-Eye. More generally, the absolute errors are explained as a combination of photometric and spectral errors.

The information of Fig. 2 of the IDL discussion is not applicable. It is admitted that the *precision* or *reproducibility* (short-range) of the Color-Eye is good. We are much more concerned about the *reliability* of the instrumental indication of color difference.

With regard to the several remaining paragraphs in the IDL discussion on metamerism, we feel that preceding remarks in this reply adequately cover the points made. However, as reviewed in the report on the Color-Eye, the conditions for ordinary visual matching of *paper* are uncommonly good: (1) large field of illumination, (2) good level of illumination, (3) binocular vision, (4) an exceedingly fine line of division between the areas to be compared, and (5) usually, smooth surfaces. As a result, it is not uncommon for experienced color men consistently to see color differences corresponding to segments on the CIE diagram smaller than 0.001. Therefore, the quotation of 0.002 in x and y as "negligible for many purposes" is most uncritical. Under conditions where one can see a chromaticity difference of less than 0.001, a difference of 0.002 would be seen as "readily visible." With regard to the desirability of reducing "industrial metamerism even where human matchers are used," the men of the paper industry have told themselves this for many years; the difficulty is extremely well known and, hence, the comment by IDL is regarded as naïve.

On the matter of the effect of heat, the reader is referred to the section in the report entitled "Temperature of the Sphere and Fading of the Standards." We miss the logic in the quotation (with regard to solarization of pot opal glass standards employed in the standardization of brightness testers) when, as a matter of observational fact, such solarization does result in much greater stability of the standards; in what sense have the standards been ruined?

It was to escape errors, even in comparative measurements, that some of the work was done with spectral transmittance, *which is independent of conditions of illuminating and viewing.* In work with paper, meticulous care was exercised to employ paper specimens within a given class which had almost exactly similar surfaces. In the case of paper, there is no way of defining or separating the "gloss" or "specular component." The reference in the IDL report to including gloss is purely operational; there is no way to exclude gloss, where one is dealing with paper. This can almost be achieved where one is dealing with papers of extremely high gloss, but such papers were avoided in the present study. Some of the worst discrepancies (calculated in a manner appropriate to *color difference* measurement) in the results observed with the Color-Eye were with papers that could be properly described as "matte."

Remarks already made in this discussion cover the need for linearity and constancy of photometric error. Our comments on the effects of dust accumulation are scarcely theoretical; after one has lived long with photoelectric reflection meters, some of which are designed to exclude dust accumulation, and observed the inaccuracies resulting from such accumulation, he feels that the burden of proof of the effectiveness of the design of a system is on the instrument manufacturer. We would have been remiss if we had not discussed the *possibility* of a time-dependence of the linearity error resulting from gradual accumulations of dust or films on the glass optics of the Color-Eye.

The reasons for working with dye solutions have already been discussed here, and in the report. Steepness of the curves is irrelevant, as the spectral reflectance curves for many colored papers are very steep. The portions of the study dealing with spectral transmittance are of an analytical nature and do *have important bearing on comparison of color and measurement of color difference, as discussed in the report.*

A trained observer *can* see the direction of a color difference, and do something about; he does this every day. One of our major criticisms of the Color-Eye is that it may indicate the wrong magnitudes for color differences and, more important, indicate the wrong directions. This is thoroughly discussed in the report.

The point made in the first paragraph under "Summary and Recommendations" has been discussed in the third paragraph of this reply. With regard to the important possibility that the instrument manufacturer be given an opportunity to comment on the planned test procedures and to read the manuscript of a report before it is submitted to APPA, our comment is that suggestions of this sort have been very carefully discussed in past years, with the decision that such practices would tend to eliminate objectivity. On the other hand, we have believed it to be a matter of importance for us to make contact with the manufacturer when we felt that a point of procedure was not clear or when any kind of uncertainty arose during the course of the work. There has always been ample time between the appearance of the report to APPA and its published form in *Tappi* to correct errors uncovered either by us or the manufacturer. In the present situation earlier correspondence between IDL and the Institute and the present "critique" under discussion have not convinced us that any conclusion made in our report on the Color-Eye of the model studied should be changed in any way.

With regard to the last comment made by IDL, we should like to repeat that our chief aim in the instrumentation studies is to assist the pulp and paper industry to obtain and to achieve better instruments and instrumental methods.

"There is a need in the paper industry for filter colorimeters which will permit the rapid and reliable checking of color. It is hoped that the manufacturers of such instruments will attack more intensively the analysis of the spectral aspects of these interesting devices and come forth with really reliable colorimeters" (*1*).

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LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel, and Events

Pacific

The joint annual meeting of the Pacific Section, TAPPI, and Pacific Coast Div. of the American Pulp & Paper Mill Superintendents Association was held at Gearhart, Ore., on May 21–23, 1953, with a registered attendance of 403.

The meeting was officially opened on May 21 with registration starting at 2:00 p.m. and a buffet supper served from 8:00 to 11:00 p.m.

On May 22, a morning joint session was addressed by Mike Paul, Crown Zellerbach Corp., on the subject "What Can Be Done to Improve Our Key People." Following this address the annual business meeting was held by the TAPPI group. This included the election of new officers.

At 12:00 noon on the same day, a joint luncheon for ladies and men was addressed by Edgar W. Smith, former president of the Portland Chamber of Commerce.

Another joint session was held following the luncheon. J. B. Heitman, Pennsylvania Salt Mfg. Co., Tacoma, Wash., addressed this session with a paper entitled "Preparation of Chlorine Dioxide for Bleaching–SO_2 Reduction of Sodium Chlorate," which will be published in *Tappi*.

Mr. Heitman described a pilot plant chlorine dioxide generator utilizing sulphur dioxide as a reducing agent for sodium chlorate in strong sulphuric acid. The description included design features, materials of construction, and operating characteristics. It was pointed out that during the past several years, interest had been growing in the United States in the use of chlorine dioxide for the bleaching of pulp. A survey of the literature in the field, coupled with visual observations of German chlorine dioxide generating equipment, led to the belief that a generator of the type developed by I. G. Farben. at Griesheim, Germany, offered significant advantages both in simplicity of construction and type of reaction utilized. Accordingly, a pilot plant generator was built and operated for the purpose of obtaining data that might interest and serve the pulp and paper industry.

The experimental generator consists of three reactors which are charged with a strong solution mixture—sodium chlorate and sulphuric acid. Sulphur dioxide diluted with air is passed through the first reactor and thence in series through the other two reactors. The main portion of the chlorine dioxide generation reaction takes place in the first reactor with the following reactors acting mainly as strippers to completely react the sulphur dioxide. Total reaction of the chlorate is accomplished and the chlorine dioxide produced contains less than 5% chlorine by weight.

Tests made with various materials for equipment construction indicated that, for sections of the generator in contact with the reactor charge or the evolved gases, unplasticized polyvinyl chloride, unplasticized Saran, ceramics, or glass were the only suitable materials.

Following the joint session on Friday afternoon, three panels were conducted on papermaking, kraft pulp, and sulphite pulp.

James H. Hull, Crown Zellerbach Corp., discussed the "Evaporation and Burning of Ammonia-Base Waste Liquor." Mr. Hull said that based on pilot plant work carried on in 1951, a plant for evaporating, burning, and recovering sulphur from ammonia-base spent sulphite liquor has been constructed and is now being put into operation at Crown Zellerbach Corp.'s Lebanon, Ore., mill. Blowpit washing is being used for liquor recovery. The liquor is concentrated to 50% solids in a two-effect Rosenblad evaporator. The 50% solids liquor is burned under two boilers only one of which is equipped for sulphur recovery. The sulphur is recovered from the flue gases of the equipped boiler by scrubbing them with ammonia solution. This scrubbing solution is then sent to the acid plant where it is used to make "raw" acid. The plant has not been operating long enough to obtain any results. However, the pilot plant work indicated that enough steam for evaporating the liquor should be obtained and that 80 to 85% of the sulphur contained in the liquor should be recovered in the absorption system.

L. R. Wood, Rayonier, Inc., Hoquiam, Wash., presented a paper on "Good Housekeeping in a Sulphite Mill." An abstract of Mr. Wood's paper reads as follows:

"In a sulphite mill, we use the term housekeeping to signify not only cleanliness but a place for everything and everthing in its place. When we speak of good housekeeping in a mill, we are speaking of a continuous activity, incorporated into the normal working processes of the organization.

"Few industries in the world require any greater respect for cleanliness than does our industry. The finished product must stand on its own in today's highly competitive market and is identified as a product which has achieved success because good housekeeping all along the production line was considered a vital and essential part of production.

"Now let us consider some of the effective ways and means for maintaining good housekeeping practices throughout the sulphite mill.

"In every industrial process, a certain amount of waste and scrap is accumulated each day. This waste and scrap should be deposited in well-painted and clean refuse cans located throughout the mill.

"Oils and greases are used in sulphite mills for many purposes. Because of their widespread use, it is not difficult to understand that drops of oil or blobs of grease occasionally are found on plant floors, platforms, stair surfaces, and possibly in the product itself. Oil and grease drippings should, if possible, be eliminated at their source and every employee should be instructed to wipe up oil or grease found on the floor as soon as it is noticed.

"Often poor housekeeping is present in the form of poor arrangement of storage space. Areas clearly marked and identified as aisles, storage spaces, receiving and shipping points, assist in keeping things in order and provide additional storage space.

"Tool housekeeping is very important. Orderly arrangement of toolroom, suitable and adequate racks, pens, and holders and an orderly routine in checking in and out, inspecting, repairing, and handling are essential. Workmen should be taught to lay out their tools on each job in an orderly fashion. It is very important that forgotten tools or dirt from a dismantled piece of equipment are kept out of the production in process.

"Housekeeping is a matter of study and planning. A definite system and responsibility must be worked out.

"Up to this point, I have dealt with the subject of good housekeeping with particular reference to quality control and costs. At this point, special emphasis must be placed on two phases of good housekeeping and those are accident prevention and fire prevention.

"Poor housekeeping is an industrious creator of unsafe conditions as well as a breeder of unsanitary conditions which endanger the health of the employee.

"Inflammable and combustible materials help feed the fires once they start. Certainly, good housekeeping is inexpensive insurance against fire."

L. A. LaFond, Crown Zellerbach Corp., Lebanon, Ore., presented a paper entitled "Ammonia versus Calcium in Acid Making, Cooking, and Screening." Mr. LaFond's paper follows this report.

R. S. Wertheimer, general manager of Longview Fibre Co., Longview, Wash., presided at dinner the night of May 22.

Dinner was followed by informal dancing in the Gearhart Hotel.

The International Brotherhood of Migratory Peddlers W.R. No. 1 sponsored their usual "Wake 'Em Up" Breakfast the morning of May 23. This feature is always well received and a high light of the Pacific Coast convention.

Following breakfast, F. J. Weleber, newly elected Chairman of the Pacific Section of TAPPI, presided at a joint session on "Dirt Removal." H. B. Charnell, Rayonier, Port Engeles, Wash., spoke on "Dirt Count and Evaluation." Mr. Charnell's paper follows this report.

L. W. Heard, Longview Fibre Co., Longview, Wash., discussed "Alhfors Screens, Centri•Cleaners and Vortraps in Kraft, Pulp, and Paper."

Harlan Clodfelder, Spaulding Pulp & Paper Co., Newberg, Ore., delivered a paper entitled "Centri•Cleaners and Vortraps in an Unbleached Sulphite Mill."

Fred R. Sievers, Crown Zellerbach Corp., Camas, Wash., presented a paper on the "Study of the Centri•Cleaner." In his speech, Mr. Sievers said "This study was made on the small Bauer Model 600 Centri•Cleaner primarily to establish the most advantageous spots in the mill for installation—also to gain first-hand knowledge of what it would do and how it would do it.

"Results obtained on the paper machine were problematical. Sized papers showed a slight reduction in size tests. On the machine using talc, about 11% of the amount furnished was thrown out.

"On screened untreated and bleached pulps, the results were good. Dirt removal was excellent. We found pressures of 45 to 50 lb. gave better cleaning where the wood dirt particles were large, such as refined screenings.

"Lime slurry was well cleaned and the graphite specks readily removed from hypochlorite.

"We found that not only consistency, but the nature and division of fibers had more effect on dirt removal than did consistencies. The extreme division of fibers caused by bleaching or jordaning allowed the use of higher consistencies, even up to 2%, with no detrimental effect to the cleaning action.

"An upgrade of color was noted on all unbleached stock. Wood dirt could be removed due to shape in spite of differences in specific gravity. The small cleaner would need more study to determine if it could be used on sized or loaded paper. Cleaning of lime slurry and bleach liquor was excellent."

"Dirt Count Comparison with Oliver's Alhfors versus Flat Screens" was discussed briefly by M. C. Kaphingst of Columbia River Paper Mills, Vancouver, Wash.

Mr. Kaphingst stated that their experience with the Alhfors Screens has been quite short. "More time is necessary to make changes and feel their way to get the operation and capacity screening of unbleached pulp, they feel is possible.

"Screens were started with 0.008 cut plates and are being increased to 0.010. Consistencies have been running 0.6% and can be increased to 0.75%.

"An increase in speed of the screen 100 r.p.m. is being effected and at the same time additional weight will be added to the vibratory mechanism.

"The dirt count has been good in comparison with the flat screens in this operation with about one half of the tonnage being screened on each kind of screen.

"There is still a need to do more experimenting on the amounts of overflows from Alhfors reject column for optimum operation when projected changes are made. The goal which is believed probable is one ton per hour per screen.

"More adequate screen showers are needed for attaining high consistency screening."

Gerald W. Hough discussed the "Lindblad Screens as Used for Screening Bleached Kraft Pulp." In his discussion Mr. Hough made the following comments:

"The Lindblad type vibratory rotary screen is being used for screening bleached kraft pulps at the Weyerhaeuser kraft mill at Longview, Wash.

"Experimental work was carried out on a Swedish Lindblad to determine its maximum capacity and the optimum operating consistency. It was also necessary to discover any operating or mechanical difficulties that might be encountered in a screen of this type. The results were influential in the choosing of the Lindblad screen for screening bleached pulp for the plant expansion at Longview.

"The mill installation of Lindblad screens manufactured by Impco handles over 60 air-dry tons per screen per day at approximately 2% A.D. consistency. After a few mechanical difficulties were corrected, the screens have presented no abnormal operating or maintenance difficulties. The power requirements are in the order of $^1/_3$ hp. per air-dry ton. The cleanliness of the accepted stock compares favorably with that from the former flat screen installation.

"After the initial mechanical difficulties were overcome, the screens have proved successful for bleached kraft screening.

"The Lindblad screen has the advantage over the flat screen of (1) higher consistency; (2) less power required; (3) less building space needed; (4) operating and maintenance difficulties are no more than for the flat screen."

Gus Ostensen served as toastmaster at a men's luncheon, Saturday noon, May 23. The luncheon was followed by an afternoon of golf.

The convention was concluded Saturday night with cocktail hour, banquet, and dancing.

It was agreed by all that this was one of the best joint conventions held in the Pacific Northwest.

H. B. Petersen, *Secretary*

Pulp Dirt Count and Evaluation

Henry V. Charnell, Jr.

Over the past years many methods have been proposed and used for the counting and evaluation of dirt. These have been applied to everything from tissue to pulp but the methods usually have proved unsatisfactory because of lack of precision or time required or both. Until a truly objective method is developed in which the dirt is automatically counted by a mechanical scanning device, we will probably be plagued by the nearly unanswerable question "what is the dirt count of a sample of paper or pulp?" This paper will review one pulp mill laboratory's approach to this question.

When we talk about dirt in a pulp being offered for sale, perhaps the first thing to consider is the question of how it looks to the customer. The answer is most easily secured, at least in theory, by the simple procedure of counting the visible dirt. Graff (*1*) in an earlier article has discussed the difficulties attending such a determination. Although we recognize the limitations of the results, necessity has dictated the selection of a simple test that can be run by shift inspectors and that will contribute to the knowledge of the product quality. The method used is as follows.

ROUTINE DIRT COUNT OF SHEET PULP

Definition

Dirt is defined as any foreign matter which is embedded in

Henry V. Charnell, Jr., Rayonier, Inc., Port Angeles, Wash.

a sheet and has a marked contrasting color to the rest of the sheet when viewed by transmitted light.

Apparatus

1. Counting stage for illumination of the sample by transmitted light (see Fig. 1).

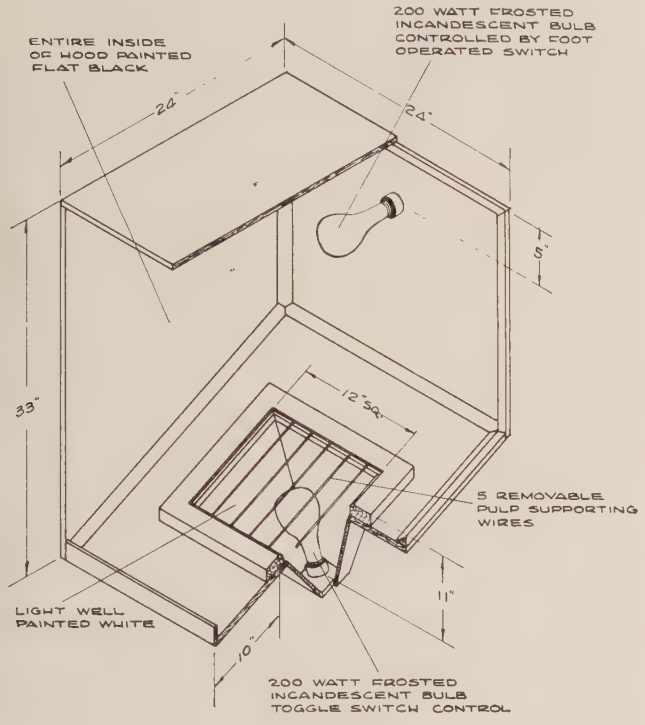

Fig. 1. Dirt count inspection booth

2. A wide field binocular microscope, Greenough type, Bausch and Lomb, Model SKW with a special drum nosepiece having a set 2.0X paired objectives. The microscope also has one pair of 10X eyepieces containing a fixed scale 5 by 0.1 mm. which is used for making accurate measurements of objects being studied.

Procedure

Cut a sheet of pulp 12 by 12 in. in size from the sample to be tested and weigh to obtain the basis weight. Place this sheet over the light on the special counting table and count the total number of specks on both sides of the sheet, giving the specks the following values to obtain the weighted (see note) speck count:

Specks having an area in sq. mm. of		*Weighted value*
0.0 –0.10	=	1
0.11–0.20	=	2
0.21–0.50	=	3
0.51–1.00	=	7
1.0+	=	10

Calculations

$$\frac{2880 \times \text{weighted speck count}}{\text{basis weight}} = \text{dirt count in specks per pound}$$

Note: In routine dirt counting, the pulp inspector estimates the weighting to be given a speck without the microscope. His correlation with the standard size-weighting chart is checked at frequent intervals.

The second problem in dirt counting is to establish the type and size of material that makes up the weighted speck count as determined above. In order to do this, a random number of sheets are selected each day so as to give a total of at least 100 specks. Each marked speck in the sheets selected is examined under the microscope for size and type of material, and the results are recorded in a similar manner to that of Adrian and Graff (*1*). Size is arbitrarily taken as the product of the long and short dimension of the speck in mm., and the specks are classified as to composition by the following method.

QUALITATIVE DIRT ANALYSIS

Apparatus

Same as under "Routine Dirt Count of Sheet Pulp."

Reagents

1. Chloroform.
2. 10% HCl solution.
3. 10% potassium ferrocyanide in water.
4. 8% phloroglucinol by weight in 12% HCl solution.

Procedure

Measure each marked speck under the microscope and classify each one according to the following key. Record the speck under the correct size interval at the bottom of the report as in the sample report form (Fig. 2).

KEY FOR SPECK IDENTIFICATION

K—*Knot Fragments:* Red to yellow nonfibrous speck of wood origin. Usually appears as a rough, knobby amberlike particle. No reaction with phloroglucinol solution.

Br—*Rubber:* Black or red rubbery speck that swells when placed in chloroform. Rubber base paints will also swell in chloroform.

C—*Carbon:* Black and when placed under the dissecting needle, crumbles into many small particles. Not affected by acid. Usually shows woody structure.

CS—*Carbonate or Sulphide:* Varied in color, usually red, yellow, or white plates. Dissolves rapidly with evolution of gas when placed in acid. May be necessary to place on slide before treatment with acid.

IF—*Iron-Coated Fiber:* Reddish or brownish fibers that give a blue coloration with acid and potassium ferrocyanide.

I—*Iron Particles:* Usually hard and brittle and give a positive iron test with acid and potassium ferrocyanide. Have the appearance of rust or rust scale.

SH—*Shives:* Fibrous in nature, usually with ray crossings in the side walls of the fibers. No coloration upon addition of phloroglucinol solution.

SL—*Slivers:* Fibrous in nature, usually with ray crossings in the side walls of the fibers. Red coloration appears upon addition of phloroglucinol solution.

R—*Resinous Material:* Specks are varied in color, usually brownish black, greenish brown, or black. Smear under dissecting needle. Readily soluble in chloroform. No fluorescence under ultraviolet light.

T—*Tile:* White to brown colored speck. Will not break under pressure of dissecting needle. Inert to usual chemical reagents.

M—*Miscellaneous:* May include any foreign particle not classified above; such as glass, oil, copper, grease, etc.

Fiber Bundle: Hard mass of stock that gives no test with reagents and appears to be normal fiber when separated with a needle.

After the specks are all classified and placed in their proper size interval, break the data down as follows:

Calculations

1. Multiply each speck by its appropriate size weighting and enter the weighted total of each classification of specks under "No. of specks." Calculate "% by number" as a simple percentage of the total number of weighted specks.

2. Multiply the average dirt count of the sheets examined by the "% by number" to determine specks of each classification per pound (column 2).

3. Calculate the "Average area" in square millimeters by multiplying the number of specks in each classification by the average of the range in which they fall and dividing the total area by the number of specks (column 3).

4. Multiply unweighted specks per pound (not column 2) by average area to secure "Area/lb."

5. "% Total area" is simple percentage of the areas listed under column 4.

6. Fiber bundles and specks marked but not found are given a weighting of (1) in figuring columns 1 and 2.

Note: In reporting the values from this procedure, the columns pertaining to area are only occasionally calculated.

After the data are secured and compiled according to the methods above, the natural question is "what shall we do with the figures?" Let us consider the routine values run by the inspectors first. Repetitive tests on a single sample, as noted later, have indicated that individual tests have very little significance in indicating the dirt count; consequently, on grades that are critical as to dirt count, a simple control chart is constructed (*2*) in which the average of groups of five counts are plotted by the pulp inspector. An example of such a chart is included to illustrate a typical run during a series of days. Previous runs or, during long runs, an earlier interval is used to establish control limits. On this chart, according to accepted statistical procedures, a series of seven or more group averages on one side or another of the center line indicates a trend. Individual averages outside of the control limits also indicate a point that is worthy of consideration.

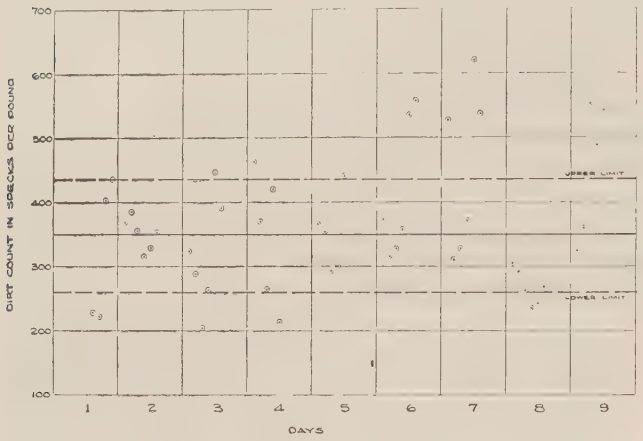

Fig. 2. Dirt count control chart

The average and limits on this chart were established from experience during the first few days of the run because the amount of wood cleaning to be used had been set at a new level. An examination of the data illustrates the use of the chart. For example, the last two points on the 6th day and the first point on the 7th day were substantially out of range, so qualitative dirt evaluations were made by methods described above. The results indicated poor wood cleaning. By the time improvements in wood cleaning became effective in the dirt count, as on the 8th day, two more high points had been recorded. The high counts at the end of the run were primarily a result of running the system out of pulp in order to change grade. Dirt, during this latter period, was mostly system material such as carbon, iron-coated fibers, resin, and a generous amount of wood dirt.

As pointed out by Graff and as verified by our experience the qualitative dirt count and size analysis is a good tool for locating the sources of dirt and gives a lead on what can be done to improve the dirt level. For example, if a number of the dirt particles fall in the size groups from 0.2 to 1.0+ sq. mm., there is a good reason to suspect that some of the flat screens are leaking dirt either around the plates or through damaged slots. This conclusion follows from the fact that one dimension of a 0.1-sq. mm. piece would be as large as 0.31 mm. which is equivalent to the width of a slot in a 12-cut plate. Of course, an occasional flat or long piece will slide through endwise even though the area is large, but in the majority of cases these will be rejected by the screen. If the dirt is small (0.01 to 0.1 sq. mm.) and is predominantly of a woody nature such as knots or shives, it becomes necessary to examine the wood cleaning operation. As indicated above, it is not to be expected that this finer material would be removed by the usual sized screen plates.

A high proportion of nonwoody dirt may be traced by the material observed. Carbon is usually fly ash from a faulty stack washer and is usually introduced through an inadvertent opening above a stream of stock. Rubber is introduced from failing rubber belts, rubber rolls, diaphragms, hoses, etc. The color and texture of the rubber speck will give some indication of the source. Carbonate specks are usually from rusty equipment or from stock that has dried onto some iron surface and then has been reintroduced into the system.

Dirt Evaluation of Pulp

Grade: Date:

Classification	*No. specks*	*(1) % by number*	*(2) Specks per lb.*	*(3) Av. area, sq. mm.*	*(4) Area per lb., sq. mm.*	*(5) % Total area*
K—Knot fragments	48	55.2	159	0.059	8.15	69.6
Br—Black rubber	..	...	...	...	...	...
C—Carbon	15	17.3	49	0.006	0.32	2.7
Cs—Carbonate or sulphide	1	1.1	3	0.015	0.05	0.4
If—Iron coated fiber	1	1.1	3	0.030	0.09	0.8
I—Iron	..	...	...	...	...	...
Sh—Shives	2	2.3	7	0.150	0.45	3.8
Sl—Slivers	5	5.8	17	0.250	1.75	14.9
M—Miscellaneous	..	...	...	...	...	...
R—Resin material	6	6.9	20	0.242	0.86	7.4
T—Tile	1	1.1	3	0.015	0.05	0.4
Not found and/or Fiber Bundle	8	9.2	26	...	...	...
Total	87	100.0	287	...	11.72	100.0

Area, sq. mm.	*Size weighting*	*Roll B-12 D.C. 306 B.W. 413 Smith*	*Roll B-85 D.C. 294 B.W. 411 Jones*	
0.0 –0.01	1	C K C K K K C R K C K C C C	K K K C C C C C C K	Region of scarcely visible dirt
0.01–0.02		K K K K C T Cs	R C K R K	
0.02–0.04		K K K K	K K If K	Region of poor wood cleaning
0.04–0.1		K R K K K	R K K K K R	
0.1 –0.2	2	K K Sh	K K K K Sl K	Region of poor screening
0.2 –0.5	3	Sl	K	
0.5 –1.0	7			
1.0 –	10			
Not Found:	1111	...		
Fiber Bundle:	111	1		

$$\frac{41 \times 2880}{413} = 286 \qquad \frac{41 \times 2880}{411} = 288$$

Tile is introduced from tank linings, and the type of material indicates the actual source.

The miscellaneous group is not given much attention unless a number of particles of the same kind appear. Then every effort is made to identify the material and find the source.

One other important use of the microscopic examination is that of keeping the pulp inspectors uniform in their weighting of specks and their count level. Each day the weighted count, as determined by actual size measurement, is compared to the individual's estimated weighting. If one person develops a tendency to be high or low he is brought back in line by a demonstration and discussion of what is desired in the way of weighting. The specks classified as fiber bundles or shadows "not found" are noted daily for each inspector. Here again, if these items become unusually high, a conference with the inspector has proved very satisfactory in pointing out the difference between a true dirt speck and a fiber bundle or shadow.

The question of significance of a given dirt count is of fundamental importance if we are to use the value in talking about a pulp. In order to try to find an answer to this question, three unidentified samples of pulp with dirt counts of 178, 234, and 451 (average tests) were sealed in thermoplastic envelopes (*3*). A tag was attached giving a code number, basis weight, and the shift on which the dirt count was to be made. The designated routine inspector counted the dirt, marked each speck on the enclosing plastic bag with a soft wax pencil, calculated dirt, and entered the dirt count on the card. Next day the pulp sheets were cut from the envelopes and placed in new envelopes to be returned for another counting. During the handling of the sheets in transferring from one envelope to another, clean rubber gloves were worn and care was taken not to enclose any surface dirt. Four different routine inspectors took part in this series, and each sheet was counted about 60 times.

At the end of the series the results were examined by accepted statistical procedures (*4*) with the following results.

Average dirt count	*Standard deviation for individual tests*	*Actual range*
178	62	74 to 330
234	50	140 to 346
451	111	304 to 715

These figures indicate that if we were to count a single sheet with a true value of 178, our tests might run from 54 to 302 and with a dirt count of 451, the range of values might be 229 to 673. Such results have led us to be highly skeptical of a single dirt count value; and, as indicated previously, in normal operation we average our tests in groups of five in an effort to get a more useful value. With groups of five, the 178 dirt count would have a range 122 to 234 and the 451 dirt count would have a range 351 to 551. Actually, averages of larger groups would be even more satisfactory in establishing the true dirt count, but in order to have a running record of dirt count we have selected the group size of five.

Although these figures are somewhat of an indictment of the dirt count values secured in the mill, we feel that the methods used are a realistic approach to the problem and highlight the challenge ahead of us to develop a better method.

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Ammonia versus Calcium in Acid Making, Cooking, and Screening

L. A. LaFond

THE purpose of converting from calcium, or dolomite to ammonia base for acid making was because ammonia is one of the best available soluble bases in acid making. This base aids in the recovery and evaporation of sulphite waste liquor since the problems of scaling in the evaporators and ash in the furnace are minimized. It was known to start with, that using ammonia would double the cost over lime rock or dolomite, but theoretically would realize a saving on the recovery of heat and SO_2 to offset this extra cost.

After Lebanon has operated $3^1/_2$ years with ammonia base we can now sum up a pretty fair comparison in both cost and operating experience.

ACID MAKING

Raw Materials Handling

Lime rock or dolomite is shipped by rail, either in gondolas or box cars, and unloaded by Hysters or crane equipment. Ammonia is shipped by rail in tank cars in anhydrous form and unloaded by its own pressure piped to an automatic system which converts it to aqua ammonia ready for pumping to the acid towers. There is a remarkable saving in the handling of ammonia over lime due to less than one half the cost of unloading and with no waste whatsoever.

The handling of sulphur, of course, would remain the same but due to the use of ammonia, we can lower the combine on the cooking acid from 1.25 to 0.85%, which in turn saves around 40 lb. of sulphur per ton of pulp stock.

Acid Plant Operation

The use of ammonia in acid making has changed the operation considerably in respect to uniformity. The ammonia and water are metered to the towers, which gives us perfect control. With calcium or dolomite we had a variation in quality of lime rock and more so in burned limes. If an acid plant was under capacity, such as ours was, you are able to increase the production around 20% with the present absorption system, provided you have ample sulphur burning capacity, by converting to ammonia. The reason is that SO_2 is much more readily absorbed in ammonia and water than it is in lime and water. Another factor of pertinent importance is the insoluble materials that cause cleanouts, due to plugging, and in turn promotes poor and sluggish operation; also the waste and disposal of the same that would be eliminated with the use of ammonia.

After $3^1/_2$ years of a uniform and smooth acid making operation, in comparison to the use of lime, it would be hard to go back to the old process.

There are also other factors to consider, such as the hazards involved in the handling of these materials, both for the operators and unloaders, which have been eliminated by changing to ammonia.

Maintenance on Acid Plant Equipment

When converting from lime to ammonia, we encountered trouble for the first 2 or 3 weeks with leaks around the towers and acid lines gasketed joints. This was due to the dissolving of the calcium deposits throughout the system. After these leaks were repaired with new gaskets the maintenance problems were reduced to less than one half. While on lime the acid pumps' packing and sleeves were replaced every other week because of the insoluble materials passing through the system, cutting the sleeves and packing. After converting to ammonia the pumps need repacking only once in 4 to 6 months. Some acid plants are equipped with acid filters, or have plans for their installation. The ammonia-base system would eliminate the necessity for the use of these acid filters.

L. A. LAFOND, Crown Zellerbach Corp., Lebanon, Ore.

COOKING

Ammonia Base versus Calcium-Base Acid

In the sulphite pulping process we depend on good, uniform chemicals, heat, and pressures with which to cook. In order to successfully do this job, care must be taken to use the proper amount of time to penetrate the wood before reaching excessive temperatures. This penetrating period is critical in calcium or dolomite-base acid, but ammonia-base acid is less critical due to faster and more thorough penetration. The faster penetration will allow the digester to cook off $6^1/_2$ hr. against 8 hr. with calcium using the same maximum temperatures and pressures.

The quality of the pulp remained about the same, except with more uniform bleachabilities. The pulp yield increased around 6%, and screenings decreased 60%, again due to the faster and more thorough penetration of the wood.

The sulphite digester cooks appreciate cooking with ammonia base over lime base with regard to the more uniform acid and with less difficulty in cooking different species of wood. Ammonia-base pulp is more easily washed, due to a lower ash content.

Digester Maintenance

The maintenance has been reduced to about half, or approximately the same as was experienced in the acid plant. The pumps can run more than twice as long without repacking, changing sleeves, and replacing gaskets. Another trouble completely eliminated by the conversion to ammonia from calcium or dolomite, and particularly calcium, is scaling of heat exchanger tube, strainer, and other fittings in the system. The major maintenance cost on sulphite digesters is the linings; and this has prompted most inquiries concerning ammonia base. This subject can only be summarized, because of the short time to obtain an over-all costwise statement. The experience so far was better than expected when converting to ammonia base with the single course, lime base lining. The first 6 months of use with ammonia deteriorated this lining rapidly, therefore, we expected about half the regular life which was from 5 to 6 years with dolomite. However, after it went through a spalling period, the life held out to within about a year of normal life. The first double course, soluble base lining with furfural joints was installed. After one year of use, to our disappointment, the lining started spalling badly. This was analyzed thoroughly and found to be caused by inferior face course brick that were underburned. We expected to replace this face course before now, but it is still holding out. The second lining has been in about 1 year, but seems to be of much better quality brick and appears to be holding out fairly well. It takes several years to round out an accurate account on digester linings, but we expect to come out in 10 years, costwise, about the same as with dolomite. Calcium, however, has a longer lining life than dolomite, so would probably expect some higher lining cost for the ammonia base.

AMMONIA-BASE PULP AS COMPARED WITH CALCIUM OR DOLOMITE

The screening capacity was increased about 20% over dolomite stock, this of course being due again to the better penetration, with less fiber bundles. With the decreased fiber bundle by the better penetration, rejects in both knots and flat screen tailings were reduced around 60%.

One problem the ammonia base presented that we did not anticipate was the rapid growth of slime because of the higher nitrogen content. The screening system, before the ammonia, was flushed out with slimicides once a week, but after ammonia we were forced to add Bufen 30 to the system daily and BSM-11 in flushing every week-end clean-up. Once we had a definite regular schedule for treatment of this growth by the use of Bufen 30 daily, BSM-11 on week-end clean-up, and a complete boilout of the system three times a year, the problem was under control.

The change in behavior and quality of finished paper on the paper machines with ammonia base stock compared to dolomite was slight, except for more uniformity.

After summing up, the over-all picture in comparing ammonia base with dolomite base is as follows:

1. Ammonia doubled in cost over burned lime.
2. Sulphur saving around 40 lb. per ton of pulp with ammonia.
3. More uniform operation, both in acid making and digester operation.
4. Increase in pulp yield.
5. Increased production due to shorter cooking time.
6. Decrease in per cent screenings.
7. Easier screening stock.
8. Increase in slime growth.
9. Less maintenance.

Delaware Valley

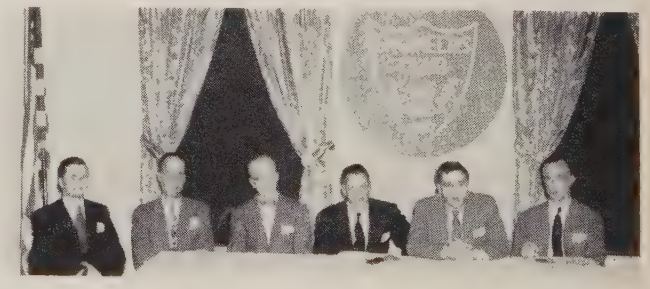
The moderator of the panel discussion at the April 23, 1953, meeting on the subject of "Paper Defects" was L. P. Thompson, production manager, Paper Div., Personal Products Corp., Milltown, N. J.

Mr. Thompson opened the panel discussion with a brief review of the backgrounds and ramifications of the subject matter. Werner Kaufman, representing the Fourdrinier Committee of TAPPI, had recommended that a section program be devoted to the subject, "Paper Defects," with particular emphasis on those which could be attributed to or become evident at the wet end of the machine. A questionnaire released by the Delaware Valley Section preparatory to the session, encompassed greater areas causing paper defects. Replies to the Section questionnaire demonstrated overwhelming preference for the evaluation of basis weight variations, particularly as they had reference to uneven flows. Closely related defects, such as uneven caliper, formation, dimensional instability, and specifications also drew considerable interest. In the realm of formation, pinholes and cloudiness were frequently mentioned, while cockle and curl were the number one items under dimensional instability.

Before introducing panel members, Mr. Thompson, who is chairman of the Tissue Subcommittee of the Fourdrinier Committee, briefly described some of work being done by that group and invited the participation of all interested persons.

Howard H. Dana, manager, Paper Div., Curtis Publishing Co., Philadelphia, represented a consumer of book papers. He is a procurer of paper and he stated that he was not an expert on the wet end of a paper machine.

"The Curtis Publishing Co. publishes five magazines, the *Saturday Evening Post, Ladies' Home Journal, Country Gentleman, Holiday,* and *Jack and Jill.* These now have a combined circulation of $7^1/_2$ million copies a week, although you no doubt realize that only the *Post* is a weekly, the others being monthly publications. These magazines combined use roughly 210,000 tons of paper a year. All magazines are edited, printed, bound, and shipped in Philadelphia or the



H. H. Dana, Curtis Publishing Co.; H. T. Nicholson, National Vulcanized Fibre Co.; E. R. Smith, Union Mills Paper Mfg. Co.; L. P. Thompson, Personal Products Corp.; W. H. Moore, National Paper Corp. of Pa.; and Malcolm Lowe, Jr., Lowe Paper Co.

Philadelphia suburb, Sharon Hill. Nearly all the paper is produced by a subsidiary company, the New York and Pennsylvania Co., which operates four mills. Three are paper mills, two at Lock Haven and one at Johnsonburg, Pa. The fourth mill is a soda pulp plant at Willsboro, N. Y. There are sulphite and soda pulp mills at Johnsonburg and a soda pulp mill at Lock Haven. The company operates woodlands in Canada, New York, and Pennsylvania to supply these pulp mills.

"Grades used are as follows:

Post	40 and 43-lb. super on insert 60-lb. machine coated on cover
Journal	43-lb. super and 46-lb. machine coated on insert 90-lb. machine coated on cover
Holiday	48-lb. machine coated on insert 90-lb. machine coated on cover
Country Gentleman	40-lb. super on insert 60-lb. machine coated on cover
Jack and Jill	54-lb. super on insert 100-lb. super on cover

"Qualities of most importance are: (1) printing smoothness, (2) opacity, and (3) ink drying characteristics. The proper balancing of these features along with the many other vital characteristics is tightrope walking of a most difficult nature. Mechanical performance of the paper is also of vital importance. We consider good operation to be one web break on the press in every 20 rolls or every 100 miles of paper. Finally, basis weight and its effect on cost must be carefully considered. Mechanically, the chief difficulties are poor roll structure (hard and soft spots across the roll), defects in the roll such as slime, calender cuts, wrinkles, etc., and paper strength. Press web breaks increase materially in the Summer due possibly to a loss of paper strength. In recent years a defect which we call 'stickers' has become very serious. These 'stickers' come, we believe, from certain binding adhesives and printing inks. They get into our papers because an important percentage of our raw materials are used magazines. We are pleased that all phases of the paper and printing industry are actively working to overcome this 'sticker' problem.

"Curtis Publishing Co. has facilities for storage of large quantities of paper. This has its advantages and disadvantages. For some reason or other stored paper usually gives considerably more trouble than paper straight from the paper machine.

"I should like to mention an unusual feature of one of the New York and Pennsylvania Co. paper machines. This machine makes machine-coated paper and supercalenders it right on the machine. Thus, after reeling on the machine only rewinding into shipping rolls is required. Who knows—maybe one day we will put a printing press right on the end of the paper machine.

"In conclusion, I should like to stress the importance of uniformity—uniformity of all basic characteristics, from edge to edge, from the beginning to the end of the roll, and from roll to roll."

Hugh T. Nicolson, superintendent of National Vulcanized Fibre Co., Yorklyn, Del., stated that to a man who eats and fights paper defects all day long, every day, it is not too nice to air them in public, but he was glad to do it as a service to the industry.

"National Vulcanized Fibre Co. makes 100% rag waterleaf paper for later treatment. None is made for commercial customers but all is sold to the company. At times this seems harder than selling on the open market. Grades of rags vary from white shirt cuttings and Hercules bleached cotton fiber to the dirtiest rags used (with the possible exception of a roofing mill). The soaps and greases which are encountered in processing the rags are dispersed and often reagglomerated to give grease spots. Such nonabsorbent grease spots in the sheet are, probably, the hardest one defect to cure. Rubber from old rags is hard to deal with. Any maker of rag papers knows how a piece of rubber will catch and work through the screen plates and then cause a defect which no one will believe could have come through the screen. Metal is no particular problem with present-day cleaning equipment as with Vortraps, etc.

"The problem of weight variation across the machine frequently occurs when there is an unintentional change in the stock. It is hoped that the answers to this type of problem will be forthcoming in this meeting. In fighting this trouble various means for correcting are used, as changing baffles, changing slices, and other methods. Usually, the trouble is overcome without knowing which of the means was responsible for the cure. In the case of thin streaks which appear, disappear, and then reappear, the use of lead weight baffles in the pond seems to help most.

"In the case of variation in caliper, one of the main causes is failure to properly adjust air on the calenders. Most people do not realize that on a 14-in. diameter chilled iron calender roll that a difference of 10° of temperature will make a difference in the diameter of calender roll of 0.001 in. In cases of caliper trouble, the use of a pyrometer in checking roll temperatures is a good place to start. A careless backtender might turn off the cooling water on the stack bearings when shutting down and then fail to turn them on when starting up. The rolls will heat up so much on the ends and pinch so hard that the paper may have to be sent back to the beaters from this one cause alone. These papers are very heavily calendered for soft papers. Consequently, moisture from the presses can cause trouble. The sheet must be dried down or blackening will result. For this use, blackening is a rejectable fault."

E. R. Smith, mill manager, Union Mills Paper Manufacturing Co., New Hope, Pa., stated: "These panel discussions usually cover such a broad field that within a single evening we can only attempt to scratch the surface. The difficulties which we are confronted with day after day are too numerous to mention to say nothing about the possible remedies. As for paper defects—we have them all. Sometimes, more than our share.

"Before mentioning these difficulties, it might be advisable to cite the products manufactured. We manufacture a high quality insulating paper used in the manufacture of high tension power cables and telephone cables. A small amount goes into coil winding, magnet wire, and transformer work. They are all specification sheets with reference to physical, electrical, and chemical requirements.

"The major physical requirements are high tensiles in the machine direction and high tears in the cross direction. Electrical requirements are high dielectric strength and low power factor. Chemical requirements are low ash content, low extractables, and free from acidity. The raw material consists of rope or sulphate wood pulp as well as various percentage blends. The most serious problem today is securing sufficient quantities of no. 1, first quality rope and subsequently the problem of cleaning of substandard dirty rope. The methods employed to clean the rope prior to the war were adequate since the rope was more plentiful, cleaner, and of a finer quality. The turnover of the old rope today has decreased to such an extent that strength values have been diminished and extractables, 'dirt, grease, fats, and oils' have increased to such an extent that present methods are not adequate. Emulsifiers and detergents have been used in conjunction with the usual chemicals employed with little success. It may be largely due to our ignorance in not knowing or not being able to determine the various types of extractables practically.

"We could explore the possibility of more efficient cleaning equipment such as is used in the woolen industry but it is felt not economically sound due to the ever diminishing supply of waste rope.

"In view of the dark picture, our laboratory personnel is in search of a substitute possessing the same qualities of strength,

flexibility, and permeability. At the same time, chemical additives are not being overlooked.

"Approximately 90% of our formation defects can be traced back to the beater room. This is typical of the old adage, 'paper is made in the beater'. The reason for this is the fact that we make a wide variety of grades ranging from 1 to 15 mils in the insulating field and up to 26 mils in saturating grades. Fibers for 1-mil paper are shorter than for the higher caliper papers. With such a broad variety of calipers to be made with the same equipment, it is obvious that the tackle cannot be suited 100% to all. To overcome these differences, for the heavier caliper sheets requiring the longer fiber, it is the practice to come down on the beater roll rapidly. This may sound contradictory but we find that our formation as well as strength is improved by employing this procedure.

"Basis weight variation in the finished paper is often difficult to remedy. Poor formation and uneven moisture distribution are only two of the possible variables which may be causing the defect. Other causes may be poor flow causing eddies between headbox and cylinder mold, entrained air. As stated previously, poor formation may be corrected in the beater room. These defects will become evident in the tensile tear, fold tests, and dielectric properties.

"To single out any one defect and its causes, the common sense approach should be by process of elimination. Eliminate the most obvious, everyday causes first rather than work on the mysterious. No driver whose car does not start would tear out the ignition wiring before checking the gas tank and other more likely causes."

Willard H. Moon, plant manager, National Paper Corp. of Pennsylvania, Ransom, Pa., stated that he had been tied closely to problems at the mill and had had little time to prepare a formal talk. However, Mr. Moon related from his experience one important factor in the control of formation on a fourdrinier paper machine making dry creped facial tissues at a speed of 1400 to 1600 f.p.m.

"Since the desirable physical characteristics of such a sheet come from a free stock (400 to 500 cc.), it is almost imperative that such a furnish be used, and that the sheet leaving the couch be in that range of freeness for easy drying, which gives the desirable characteristics of softness and bulk. This high freeness, however, would give us a very poorly formed sheet because of the tendency for agglomerations and its quick draining characteristics on the wire.

"Before giving the one basic idea we have in the formation of the sheet, I would like to make the following assumptions:

1. That the fiber or furnish selected is the proper one, and that any extremities in the type of fibers going into the blend receive a balanced treatment.
2. That the state of dilution is sufficient, and that velocities of flow are high enough so that no agglomerations are formed.
3. That the machine headbox and slice are reasonably well designed.
4. That there are no holy rolls right at the point of slice discharge.
5. A semipressure formation is being used with some water discharged through the wire at the slice.

"The one variable which we have found to enable us to get better formation, without the loss of other desirable characteristics, is that one called, 'retention'. Our definition of this term is that percentage of the stock which is couched off relative to the amount of stock placed on the wire. By varying the retention we are able to change the relative freeness of the stock, insofar as drainage is concerned, and yet not materially change the freeness of the sheet itself. Thus, we are able to match the fourdrinier water removal equipment with a stock of a given freeness which will enable us to obtain the most desirable formation within the capabilities of the machine in question. The reason for this is that the shorter fiber not being retained on the wire is recirculated with the raw stock, thus tending to decrease the headbox freeness. By varying the percentage of this short stock being recirculated, it is possible to control the headbox freeness. Variables can destroy the needed balance. Such variables must be controlled.

"A sheet once formed must be protected from upsetting factors down the wire. Water deflectors on the bottom side of the wire must be designed so as to remove the water without creating a vacuum in so doing. Slotted covers on suction boxes are better than drilled holes which allow the water to travel to the side. The sheet must be dried sufficiently so that the guide roll cannot throw water and cause pinholes.

"Bulk, crepe, and stretch factors must be properly adjusted to meet the national standard of $4^1/_2$ in. diameter on a firm roll having 500 two-ply or 1000 single sheets. These depend, primarily, on the degree of tightness of the sheet to the drier. Whether this tightness is due to pressure or adhesives, it is a critical factor in creping. The more difficult the sheet is to get off by creping, the more bulk will be found. The proper bulk thus obtained must not be pulled out and the sheet must be able to withstand the cutoff in converting."

Malcolm Lowe, Jr., superintendent, Lowe Paper Co., Ridgefield, N. J., described the operations performed by his company. "Basically, Lowe Paper Co. are off-machine coaters. They have a small board machine run exclusively on folding boxboard for coating. Other types of coating include release coatings on kraft papers, heat-seal coatings, and grease-resistant polyethylene coatings.

"The mill practice, formerly, was to take two samples of large dimension to check basis weights. This was found too insufficient to guarantee freedom from basis weight complaints, so three samples were taken. Currently, nine samples, each 9 by 10 in. in size are taken across the sheet. Better control results from the information thus gained.

"Dimensional instability is evidenced in curl tendencies, particularly, on a single-lined sheet having strong fibers on one side only and this becomes worse when a casein-bound clay coating is added. Such curl problems are licked by several means, including control of liner furnish and furnish treatment, and also with unbalanced starch water box treatment, either in the number of boxes or in concentration of starch.

"Formation is the greatest problem, especially on lightweight board. Help in this direction is expected when two counterflow vats are to be replaced with two direct flow vats this coming Summer. Consequent wire marks are anticipated but these marks are expected to be offset by the replacement of the two plain extractor rolls (having fine wires) by a suction drum roll and the addition of more primary plain and suction presses. Other means of alleviating wire marks will be by the use of fine cylinder wires, proper felt design, and smoothing presses.

"A secondary problem is that the sheet is far from square strengthwise. Particularly on a fold of 180° (bender). It is expected that the direct flow vats will help this and also allow the use of longer stock and at the same time get a better formation.

"In liner furnishes it has been the practice to use about 25% deinked stock made from cutting, greeting cards, etc. With the new adhesives, plastics, inks, etc., in use, despite the dirt removal by Vortraps, once in awhile it becomes necessary to pump this stock over into the filler system.

"Drying offers some problems in getting consistent moisture contents, especially so on coating, when starts and stops are necessary. It becomes quite a game to outguess the customers' (boxmakers') requirements. This is especially true at the change in seasons when curl and cracking become critical. Some moisture control in the sheet is possible, but the best means is to have adequate moisture control in the box shops.

"Statistical quality control procedures are being instituted at Ridgefield and are being received very enthusiastically. Even in a short time much is being learned about quality and defect correction."

F. J. Lovegren, P. H. Glatfelter Co.: Does the use of hawsers made of materials such as nylon affect the used rope market?

Mr. Smith: Not as far as we are concerned; we have not yet encountered hawsers containing nylon or synthetic fibers.

C. R. Calkins, Riegel Paper Corp.: Mr. Nicolson, what density or specific gravity were you referring to in your discussion of caliper differences?

Mr. Nicolson: In pounds per mil, 11.5 is the tops. We still don't know why a calender should get hot in one place, nor why it should not remain the same from hour to hour.

John D. Lyall, Armstrong Cork Co.: What influence does a headbox overflow have? Especially, on long-fibered stock?

Mr. Moon: In my experience the overflow is not used; the water and stock are adjusted so that it all goes over the wire.

Kenneth S. Whisler, P. H. Glatfelter Co.: Mr. Dana, do you experience trouble with loose ends going through the press?

Mr. Dana: We would not like it. However, a slight softening on one end might help under particular conditions. Such a condition might result from a heaviness of the form on one side, which creates a tendency to crabbing. With a large inventory it is possible to help this situation by selecting rolls which were made wrong in the right places.

Mr. Whisler: Could this same condition cause margin variations? For example, a 50-in. roll across the plate may have a wavy edge even though the roll when full was sound and hard.

Mr. Dana: Yes, this could cause trouble. It is necessary to adjust the presses constantly from roll to roll. Such conditions are correctible in most cases.

L. E. DeLauter, Curtis Publishing Co.: A roll which is baggy on one end can cause register trouble for a plate or two or a page or two. If the result is bad the roll is thrown off. Such a roll which is baggy for a foot of diameter can't be run.

J. Howard Wright, Bauer Brothers Co.: In the case of specification papers, what is the recommended control to correct headbox eddying or fan pump surges which might cause head variations of $^1/_8$ in.

Mr. Nicolson: What speed?

Mr. Wright: Thirty-five feet per minute, on a dense sheet.

Mr. Nicolson: My experience has been from 35 to 400 f.p.m., and this is most critical at lowest speeds. One of the most effective means is to shift the lead weights in the machine pond. If you are thinking of cylinder machines, I am not your man.

Mr. Smith: It depends on the design. One of our machines, a Pusey-Jones, has a conventional up flow headbox fed by a vertical pump with a flow spreader circle and an overflow dam. In this system there is no fluctuation unless air is entrained. Entrained air is more critical than variations in flow. On the other machine, there is what we call a standpipe overflow, and there is always a certain amount of white water discharged. This acts as a precaution against entrained air. At the highest speeds 6000 g.p.m. will bring in air, but there is no trouble from the centrifugal pump itself.

Mr. Thompson: I have found a small gate at each end, perhaps one in the center or even one which goes clear across to be effective in taking care of pump variations.

George K. Boger, Jr., Paper Products Mfg. Co.: In deinking operations, has anyone here any experience with use of the Curlator? There are reports that it does a fine job in separating fiber and objectionable materials merely with the use of wetting agents alone.

Mr. Thompson: I lack experience, does anyone else have anything on this?

W. D. Rice, P. H. Glatfelter Co.: Would you redefine the question? Is it a means for segregating for screening?

Mr. Boger: It has various functions. It would be interesting to run tests.

Mr. Wright: I know of a parallel application on magazine stock. Three Bauer double-disk refiners are used ahead of the hydrapulper.

Mr. Rice: What is the effect on strength?

Mr. Wright: This treatment does not reduce the freeness or fiber length. I would like to ask Mr. Lowe if there would be any merit in attaining cleaner filler stocks? Either from strength considerations or that of silt behind making boards?

Mr. Lowe: I assume that you are speaking of dirt finer than that retained by 10-in. Vortraps. For our filler we use a premium price news and because of this are not particularly afraid of shiners in the stock. We want no part of the asphalt common to cheaper filler stock. If it were possible to eliminate wax and asphalt 100% there might be an economic balance in favor of equipment for cleaning. As for silt, fine dirt, we do not have an awful lot, not enough to justify its removal on strength or formation accounts. It might be justified on the basis of reducing wear on knives on our cutters, trimmers, and also on those of our customers.

Mr. Lyall: What can be suggested as a remedy for chattering of water boxes on a machine making heavy flooring or roofing felt?

Mr. Nicolson: I don't know about your case, but I have found that it can result when micarta or panelyte covers are too thin from grinding in wear usage. The cure is obvious for this. It is not because of too much vacuum but by springing of the cover itself.

Mr. Lyall: Operations are at speeds from 200 to 400 f.p.m. with 4 to 5-in. vacuum.

Mr. Thompson: I have heard of investigations of rota-belt suction equipment for tissue applications. Perhaps, this would be a solution.

Mr. Lyall: We have the same experience on Monel, end grain wood, flat grain wood, and micarta covers.

Mr. Thompson: Some surveys have shown a preference for end grain maple.

Mr. Lyall: We find no change in chatter with different cover materials.

Mr. Moon: Have you checked the cut-off? Is water removal satisfactory?

Mr. Lyall: This is OK. We have also checked the seals on the suction pump.

Question: Would oscillation of the boxes help to cure the trouble?

Mr. Rice: This looks like a chance to evaluate a rota-belt.

Mr. Thompson: TAPPI is considering inaugurating projects to study the design of deflectors and also the design of suction boxes. If any of you would be interested in seeing such projects undertaken under TAPPI grants, it would be in order to write TAPPI and say so.

Mr. Lowe: I would like to know your opinions of the effect of varying steam pressure in driers on the quality of board. For example, an exaggerated case, 10 as against 125 p.s.i. on the same 48-in. diameter driers, assuming the same moisture in and out of the drier section in each instance. (Speed change might account for the difference.) Assuming further that there are no visible defects such as picking, blowing, featherbedding, etc., could you expect a loss in strength?

Mr. Wright: It might depend on how the graduation by zones was done.

Mr. Lyall: In roofing felt, differences of 25 to 65 p.s.i. have shown no effect on strength with all driers operating at uniform pressure.

Mr. Rice: There might be adverse aspects in connection with curl due to shock drying. In such cases graduated drying helps. The high temperature should be attained gradually or initial stresses will be locked in the sheet.

John P. Weidner, Container Corp. of America: We have experienced occurrences of sheets and board, which were apparently satisfactory off the machine. In some cases they were OK, but in others trouble developed later in curl, cockle, and bender. The cause was thought to be nonuniform drying throughout the sheet. The solution was to decrease the moisture content off the driers and equalize it through. There was no blast on the last driers to lock in the stresses. It has been our experience that moisture applied at the calenders is not sufficient to plasticize the sheet against this type of trouble.

Carl Ackerman, Union Mills Paper Mfg. Co.: In making electrical insulation transformer board at a New England mill a drier operating at 60% of capacity was producing board with defects which gave trouble in the finishing operations. The 60% capacity caused an open space between the sheets. The trouble was overcome by operating at peak drier capacity.

Mr. Lowe: I am interested in a defense for hotter driers. More speed gives less contact time. The old argument is that you can't burn water, but I believe it is possible to burn the sheet if all the drying capacity were contained in two huge driers so that the usual alternating and intermittent contact were not present.

F. J. Lovegren, *Acting Secretary*

May Meeting

The May meeting of the Delaware Valley Section of TAPPI was held at the Engineers Club in Philadelphia on the evening of May 28. Over 80 members and guests attended.

John Weidner opened the meeting substituting for Harold Brill. He expressed his admiration of Mr. Brill's work as chairman, and read a message from Mr. Brill expressing his appreciation for the cooperation of last year's officers. Frank Lovegren then assumed his duties as new chairman and introduced the new officers.

The meeting was turned over to John Macadam, chairman of the E. J. Albert Award Committee. Mr. Macadam announced the judges of the contest: Charles A. Shubert, W. B. Morehouse, and Donald Bradner. Mr. Macadam introduced the contestants: Vincent Moser, Rohm and Haas Co., "A Nonstatistical Approach to Improving Wet Strength Resin Evaluation"; R. J. Becker, Riegel Paper Corp., "The Canadian Standard Freeness Test versus a Drainage Time Test

for Highly Refined Stock"; and F. J. Newhard, Scott Paper Co., "Retention of Wet-Strength Resins by Various Types of Pulp." Mr. Macadam announced the judges' decision. R. J. Becker was awarded the traveling trophy and prize.

C. R. CALKINS, *Secretary*

Chicago

The Chicago Section met at the Chicago Bar Association rooms, Chicago, Ill., on May 18, 1953.

Douglas Wallace of the Procter & Gamble Co. presented the paper which follows:

Packaging Material Specifications for High-Speed Automatic Machines

Douglas Wallace

IT IS a pleasure to be here tonight and to see so many people who are interested in the present-day trend to high-speed operation. We at Procter & Gamble have a very high regard for the job that the technical people are doing in the pulp and paper industry and realize that it is through your efforts that help will come to us in our problems of operating high-speed packing equipment.

Douglas Wallace, Procter & Gamble Co.

I was asked to speak on "Packaging Specifications for High-Speed Automatic Machinery." Since our work is mainly with cartons and corrugated containers, I will confine my remarks to these materials. I will not discuss the specifications that are written solely for product protection and sales appeal, except as they affect machine operation, but will limit my remarks to the specifications that are necessary to make the cartons and containers run on automatic machinery and especially on high-speed automatic machinery.

I don't know what your committee had in mind when they used the words "high speed," but I would like to think about them jor just a moment. I believe we have had high-speed lines for many years, but that each year they have become a little faster. I like to think of the term "high speed" as meaning the upper limts of speeds that are being run today and the speeds at which the engineers plan to run in the foreseeable future.

As the speed of the lines go up the natural consequence is that the allowable tolerance on the packing materials goes down. Where it will end, I don't think can be estimated.

I think of our own packing lines as having a variable speed drive on them and management and the engineer standing beside them turning the speed up and up until the packing material will no longer operate and then turning to our group (the Packaging Div.) and saying "When are you going to get us some good materials?" It is our job, with the cooperation of you gentlemen, to find these so-called good materials.

With today's competitive market and labor setup there is a tremendous incentive to turn that crank up and up. The carton and container suppliers have done a good job in building better materials, but there are tremendous fields ahead that will have to be explored and conquered.

The one word that I believe keynotes the whole subject of high-speed operation is "uniformity." We need some special features such as prebreaking for high-speed operation, but just as important is "uniformity." Uniform size, uniform stiffness, uniform gluing, uniform scoring, and so on down the line.

So far, at least, the engineers have been able to build machines that will run cartons that can be made by a good carton supplier, but they can't build machines, at least high-speed machines, that will run cartons that are not uniform.

By uniformity I mean both uniformity within the material from one supplier and uniformity between the materials from several suppliers even though they may be using entirely different equipment.

How do we get these uniform materials? By telling our supplier what we need. That sounds simple, doesn't it? But as most of you know even better than I do, it is a very complicated task to tell the supplier what you need. You notice I didn't say tell the supplier how to make the box, I said tell the supplier what you need. In other words, we feel that the supplier should be given as much freedom as possible in making the material, provided it will meet our requirements. We want to specify performance wherever possible. To get down to specific points I want to discuss some of the ways we can tell the supplier what we need so that he can give us uniform cartons and containers.

Let's discuss cartons first.

I feel the blueprint is the key to the fabrication specifications. It is there that the exact size and style are determined. Unless every angle, radius, and dimension are exactly tied down you force the die maker to insert his ideas into your carton, and I don't believe you will ever find two who will do exactly the same thing. We still have a few minor items for which there is no blueprint and some of the variations that we see when a new supplier makes the job are surprising.

We do not show any dimensional tolerance on our prints as we feel that the size must be as nearly perfect as the best die makers can make it. There is enough of a size problem because of board shrinkage without the additional problems of variation of die size. In talking about the size of a carton most people immediately think of a carton opened out flat with a scale laid across the score lines. We feel this is only a part of the picture of the size of a carton. The other approach is the size of the finished or folded carton. Let me show you what I mean. Here is one of our cartons. We are concerned with the distance across the width of the folded carton. Small variations in the make-ready and gluing can cause this dimension to vary slightly, and this is important to us as the ears are very difficult to seal unless the carton is absolutely square.

We are interested in the thickness of the finished carton on both edges and at the glue seam. If these are not in the cor-

The May 18, 1953 meeting of the Chicago Section

DOUGLAS WALLACE, Packaging Div., Procter & Gamble, Cincinnati, Ohio.

rect proportion the cartons won't line up properly when several thousand are stacked on the feed rack. With high-speed operation the number of cartons on the feed rack has increased proportionally, and they must line up squarely in order to feed properly.

Along the same line we are interested in how high a given number of cartons will stack and whether they will stack level. On lines with vertical feed hoppers, cartons that stack too high, or have too much fluff won't feed properly.

We have found it necessary to show exact ink bleed allowances on the blueprint. You say sure this is a good thing to specify, but what has it got to do with high-speed operation? Just this, as the speed goes up and the sealing time goes down the size of the sealing area becomes important especially on small flaps like our carton ears. We had to be very strict to be sure that the suppliers were not adding more ink bleed to the area to which the ears sealed. The amount of bleed has been a give and take affair that we have had to work out with our suppliers.

Prebreaking has probably been the most outstanding item that has helped increase line speeds. It is not something that we obtained overnight but were forced to be patient and work with our suppliers for a number of years. In fact, I don't think we are through yet, as I don't believe we have ever seen a carton with too much prebreaking. Prebreaking may have been a double-edged specification as the suppliers have had to give us better boards that would withstand the prebreaking.

Our blueprints tell the supplier which score to break and how much. This is a case where we tell the supplier how to make the carton rather than specify the performance wanted, but one of these days we may find a good measure of prebreaking that will be acceptable.

Some of the other more obvious points that should be brought out on the blueprint or the specification sheet are grain direction; location of printed and unprinted panels; type of product to be packed in the cartons, solids, granules, or powder; type of filling machine used; size, style, and strength of opening device, and location of any special cutouts to separate cartons made on a combination run. Any special scores such as cut or perforated scores should be noted. On our type of filling equipment we need particularly good horizontal scores to get good square sides for the ears to seal to. The possibility of some reverse scoring, especially with rotary cutting and scoring equipment, should not be overlooked.

So much for the fabrication specifications; let's go on to some of the board specifications as they affect high-speed operation. There are two basic points here, strength and sealability. If the carton is too flimsy to stand up in the line it's no good or if it won't seal it's no good.

Let's talk about sealability first. Most any board can be sealed with the proper time, heat, and glue, but will it seal with the time, heat, and glue on our machine? We can't change our lines from hour to hour, so again the cartons must be uniform and within limits. The two tests that we have found helpful, and I repeat helpful because we know they are not the last word, are the ink absorption test and the water drop test.

The ink absorption test is just a simple test of placing a drop of ink on an unprinted surface and tipping the carton up so that the drop of ink will run down the board. If the ink stains the board evenly along the full length that it has run, it is a good indication that there is no wax or other material that will repel a water-based adhesive.

I will read the water drop test exactly as it appears in our standards.

Water Drop Test. A drop of water falling from a height of $2^1/_2$ in. to show initial wetting of the board in the unprinted front liner in 5 min. maximum, and to be completely absorbed into the front liner in 5 min. minimum, 45 min. maximum (ideal 5 to 30 min.) and into the back liner in less than $2^1/_2$ min. (ideal 25 sec. to 1 min.). Initial wetting occurs when the board under and around a drop of water darkens from absorption of moisture.

This test has not solved all of our sealing problems by a long way, but it has eased them considerably. Time and time again we have found that we have more trouble sealing board that does not meet the specification than we do with board that does meet it.

I don't mean to imply that this specification is correct for all gluing. We think it is pretty close for the time, heat, and glue on our machines, but other lines with different conditions may need considerably different properties.

The principal objection to this test is that a drop of water must be absorbed deeply into the board before it disappears whereas the adhesive film is so thin that the water is absorbed only in the top few thousands of the sheet. It is because of this that we look for initial wetting. We have found that if there is initial wetting the length of time for the drop of water to disappear is not as important as if there is no initial wetting.

We are hoping that someday one of you gentlemen will be able to show us a better test for sealability.

I said the other basic point on board specifications was strength. We like cartons made from good stiff board as long as it will score well. We haven't as yet found it necessary to give numerical specifications but the tests are certainly available, such as compression, stiffness, burst, and tear.

I will predict that in our own case it won't be too long before we will start specifying stiffness, because at the higher speeds we must close the door on the soft limp cartons.

While ink is usually thought of as an item of sales appeal having little effect on the packing line, there are several points of concern here. The first is rub. With higher speeds there is apt to be more friction and more rub; also the product may have a greater tendency to be spilled on the equipment and rub the ink. A box that must be thrown out because of rub is as bad as one that won't run at all, maybe worse because of the temptation to pack it. There are a number of rub testers available that do a pretty fair job of measuring rub resistance. We keep blueprints available for any of our suppliers who want to make a rub test like ours.

The second point is heat resistance which is somewhat similar to rub. With the higher speeds it is the general practice to use more and more heat to help seal the cartons. If the ink comes in contact with the heat it may be necessary to use special inks that will not melt and smear with heat. This was brought home to us very forcibly when we first started using cartons printed by the gravure process. The ink on the side of the cartons to which we seal the ears was being melted and wiped off by the heaters. We did what we could with the heaters but it was necessary to develop special inks to correct it.

The other item of concern on inks is slip. This is a new thought to us and we have no specifications on it as yet, but we do find that there is a difference in the way cartons run depending on how slippery the printed surface is. The difference between a gravure carton and a letterpress carton with a lot of offset spray is very noticeable. Someday we may want to tie down this difference.

So much for the specifications for the cartons themselves, but let's talk a little about the packing of the empty cartons by the supplier so that they will arrive at the plant in good condition and in a form that can be unpacked conveniently. It is important for a supplier to know exactly how the customer wants his cartons packed. With high-speed operation the operator does not have time to unpack cartons that are packed any way but the standard way that was designed for his job. Let me give two examples of seemingly minor points that can cause us trouble.

Most of our cartons come in string-tied bundles of 50 cartons. We specify that the knot in the string be in a certain location with reference to the cartons because we place the bundles on the feed rack before removing the strings. After

the operator places a number of bundles on the rack she cuts the strings and pulls them out. If the knot is in behind the cartons, it will pull cartons off of the rack when she tries to pull the string out.

Another example is the direction the cartons face in the case. Unless each case is packed the same way with respect to the printing on the outside of the case the operator will not know which end of the case to open and will have to turn a lot of cartons around when she opens the wrong end.

I haven't said much about protecting the cartons from damage, this, of course, is important as damaged and warped cartons won't run well on any automatic packing line. We feel that there is a joint responsibility here in that the specifications must be for a pack that can be made strong enough, and the supplier must use good materials and pack and load the materials properly.

The best means that we have found for specifying the packing is by the use of photographs. In fact we use photographs in our specifications wherever we can. We find that a photograph is more often complied with than is the written text.

Maybe at this point I should mention some of the things we don't want. I am thinking of such things as unglued side seams, uncut flaps. If a line is running at 200 cartons per min. and one half of 1% of the cartons have unglued side seams and each unglued side seam jams the machine and causes a 2-min. shutdown, the efficiency is reduced to $33^1/_3\%$ in addition to losing maybe 10% of the cartons because of the jam in the line.

When we find 100 bad cartons all together we can shut down and throw them away without too much trouble, but when they are scattered throughout the shipment we are in serious trouble. It is things like this that separate the good suppliers from the fair ones.

Let's now take a quick look at the specifications for corrugated containers. To operate a packing line at high speeds you must be able to remove the product satisfactorily, and there are a few points on container manufacture that can cause trouble if the specifications are not properly written and followed.

Probably the most important is size. If the case is too small it may not pack and if it is too large it may not go through the sealer. Also flap size may be a problem in some sealers. Some suppliers think they should have a tolerance of $^1/_8$ in. in size. We feel this is too much. We like our cases to be a close fit to the product to prevent the cartons from moving and rubbing. A case designed with a close fit and made $^1/_8$ in. under size can give all kinds of trouble on a high-speed line. If hand packed the operator may be packing a case about every 12 sec., and at this speed she does not have the time or the strength to force the cartons in the case. What happens? We have a labor problem on our hands and the boxmaker has a bad reputation in the eye of the factory. If it is a machine pack the machine will probably jam and the whole line shut down.

For about the same reasons the boxes must be well scored. It doesn't take an operator more than 2 or 3 min. to notice when a lot of cases are not scored properly.

The only thing we can do is to put extra help on the line. If the girl's job is engineered so that she has only one hand available to break back a flap and the box is so stiff that it takes two hands to do the job, she is lost. I don't say she couldn't be shown or learn how to revise her motions, but at least it is a matter of handling a nonuniform item requiring a change of habits that are not readily changed.

The board must have good bending qualities as many of our lines require the flaps to bend out a full 180° while being packed.

We do not specify what flute is to be used because we have insisted that our engineers design sealers that will seal either A, B, or C flute without too much adjustment. In fact, some of our sealers run A and C or B and C alternately and at high speeds. On some users' equipment I can see where they could be in serious trouble if the flute were not uniform.

The manufacturer's joint is something that should be specified accurately by the user both as to the type of joint and its location with respect to the printing. On some of the new automatic case feeders, I believe a box with a joint in the wrong panel might not run at all. I know that on some of our case sealers the boxes run better if the joint is in a certain location. Also on some of the hand pack lines the stitched joint gets in the operator's way if it is in the wrong position. In case some of you are wondering why we don't turn the box around, we require that the printing on the cartons and the printing on the cases be packed in the correct relation to one another so that the case can only be turned in one way. We show this on a photostat that gives the details of the layout of the panels and printing.

The sealability of containers can be a severe problem as there is seldom enough room to increase the length of the compression belt as the lines are speeded up and we all hate to spend more money for faster adhesives. We have not found it necessary to specify a water drop test here, but one could be worked out if necessary. I will say that we have, in general, had more trouble with boards that were too absorbent than with boards that were not absorbent enough. We have told our suppliers what type of adhesive we used and what our compression times were and have found that to be satisfactory.

As was pointed out for cartons, nonuniform packaging of containers can shut down a packing line. We find it necessary to tell the supplier how may strings to use in tying the bundles and in what direction to run them. Also we prohibit the turning of some cases in the bundles. Not long ago, I saw a line shut down just because the supplier had turned the top case in each bundle over, apparently to help the tape adhere better. The supply man had been instructed to stack the cases a certain direction, and, assuming they were all turned the same way, had stacked them as he observed the top case. When the operator started to pack them she found that only one container out of 20 was positioned correctly and she didn't have time to continually turn the others around.

You have heard a lot about the formal specifications and now I want to mention another phase of our work that we feel is an important part in telling the supplier what we need. That is the personal visit and follow-up. When a new supplier starts making materials for us, we try to have someone from the technical packaging group visit the supplier to sit down and go over the specifications and point out the problems and explain the reasons for some of the specifications. In addition to this, we usually test samples in our laboratory or at the factory ahead of the production run and may have a man at the supplier's plant when the first run is made. Let me repeat again we are not trying to tell the supplier how to make the cartons but merely to catch any problems before they reach the factory.

Besides having the individual factories check each receipt, our main laboratory periodically reviews all materials in an effort to catch any problems before they become serious. Also we try to visit our suppliers quite regularly to discuss any problems or new ideas.

In conclusion, let me point out some new specifications that are in the wind and two of the old ones that are still giving trouble.

Possible new ones are performance tests for prebreaking and score bending, a measure of the rubbing friction that prevents cartons from sliding properly in the line, and performance specifications for board strength rather than weight and caliper specifications. As you can see all of these would be along the line of specifying performance rather than telling the supplier how to make the box.

The two old ones for which there is still a real need for a better means of measuring and specifying are the sealability of board and ink rub. I believe your organization has com-

mittees working on both of these problems and we at Procter & Gamble certainly wish you luck.

Empire State

The Empire State Section of TAPPI held its annual Summer meeting at Whiteface Inn, Lake Placid, N. Y., on June 8–10, 1953. There were 257 registrations.

On June 8, a business meeting was held at which the officers for next year were elected. The officers elected were: chairman, D. Chase Mather, Carthage Paper Makers, Inc., Carthage, N. Y.; chairman-elect, Fred Somerville, Armstrong Cork, Fulton, N. Y.; secretary-treasurer, Ralph N. Prince, J. and J. Rogers, Au Sable Forks, N. Y.; representatives-at-large, George Martin, General Dyestuffs Corp., and W. R. Willets, Titanium Pigments Corp.

The Junior Award papers were presented at the business meeting. John Hankey, Oswego Falls, Sealright Div., Fulton, N. Y., presented "Weight Factors of Pulp." Wm. J. Copeland, International Paper Co., Glens Falls, N. Y., presented "The Reclamation of Waste Paper." Three judges decided that the papers were equal in merit and divided the award of $100 between the contestants.

A get-acquainted cocktail party was held following the business meeting.

The technical portion of the meeting began on Tuesday, June 9, at 9:30 a.m. R. H. Wiles was chairman in charge of this meeting.

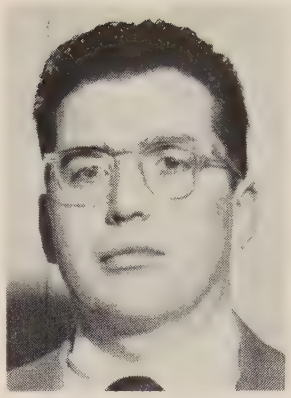
"Air Removal from Paper Machine Stock—The Deculator," by G. D. Hughson, research engineer, Canadian International Paper Co., Gatineau, Que., and John C. Stewart, sales manager for The Rotaraed Co., an associate of Clark and Vicario Co.

Mr. Hughson described and discussed the application of the deculator to high-speed newsprint machines in Canada. Canadian International and Rotaraed Co. have pioneered in this field and considerable development work was done on the deculator in Gatineau. Mr. Stewart answered questions from the floor on applications of the deculator other than on newsprint.

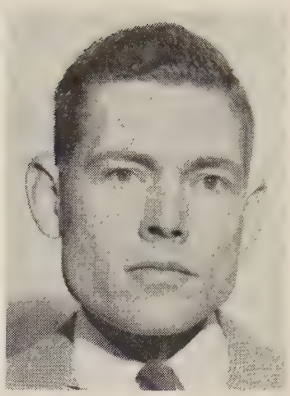
"Semichemical Pulping of Hardwoods," by H. L. Field, technical supervisor, West Virginia Pulp and Paper Co., Mechanicville, N. Y.

Mr. Field discussed the new 100-ton per day bleached hardwood plant now in operation in his mill. This is one of the first, if not the first, application of neutral sulphite semichemical pulping of mixed eastern hardwoods producing a high-grade pulp for book paper furnish. A completely new mill and wood preparation plant was built.

W. R. Willets, Titanium Pigment Corp.; D. C. Mather, Carthage Paper Makers; G. K. Storin, Niagara Alkali Co.; F. G. Somerville, Armstrong Cork Co.; R. N. Prince, J. & J. Rogers Co.; G. B. Martin, F. C. Huyck & Sons; R. M. Drummond, International Paper Co.; H. D. Cook, Sweet Bros. Paper Mfg. Co.; J. W. Crocker, Sandy Hill Iron & Brass Works; P. L. Haggerty, George La Morete & Sons; and C. J. Sibler, West Virginia Pulp & Paper Co.



John Hankey, Oswego Falls Corp.



W. J. Copeland, International Paper Co.

"Semichemical Pulping of Hardwoods," by R. M. Husband, research associate, College of Forestry, State University of New York, Syracuse, N. Y.

Mr. Husband's paper consisted of results obtained experimentally, using a new method of semichemical pulping and bleaching of hardwood. The results obtained from sodium sulphite alone and in conjunction with sodium bisulphite were evaluated.

"Some Causes and Means of Elimination of Static Electricity," Lewis E. Walkup, Battelle Memorial Institute, Columbus, Ohio.

Professor Walkup presented a demonstration and explanation of how electrostatic charges are generated and eliminated in paper and textiles, and how these principles apply to practical situations. The demonstration and explanation were presented in such an interesting manner that it was above the cut and dried level generally thought of when considering static electricity.

The second technical meeting was held Wednesday morning and presided over by C. H. Hager, Jr., Diamond Match Co., Plattsburg, N. Y.

"Masking Airborne Malodors—Utilization of Aromatic Chemicals in Industrial Odor Abatement," by B. K. Tremaine, odorologist, Industrial and Aromatic Section, Organic Chemical Dept., E. I. du Pont de Nemours and Co., Wilmington, Del.

Mr. Tremaine called on his wide experience gained by servicing the pulp and paper industry in New England and Canada, and presented a well worth-while paper explaining the field for odor abatement in the paper industry. These new aromatics are not to be confused with the widespread publicity given to "chlorophyll." Recommendations for the application of industrial odorants, based on weather changes, were suggested.

"Dirt Removal with the Centri•Cleaner," by E. L. Rastatter, technical director, The Bauer Bros. Co.

A broad review of the present uses and potentialities of this new piece of equipment in the pulp and paper industry. A discussion period was held for comments of representatives of several mills who have this equipment.

"Atomic Power," by Edward C. Fuller, professor of Chemistry, Champlain College, Plattsburg, N. Y.

Mr. Fuller was associated with the Manhattan Project during World War II. He is singularly qualified to talk on the subject of atomic energy and power, and gave a down-to-earth presentation which was enjoyed by all.

A large number of members enjoyed themselves on the boat trip and the trip to Whiteface Mountain, which included the "North Pole."

About 30 persons took advantage of the opportunity to go through the MacIntyre Development, Titanium Div. of the National Lead Co. at Tahawus, N. Y. Those attending were escorted through the works, and lunch was served through the courtesy of the National Lead Co.

Mills en route to Lake Placid extended an invitation to those who were interested; the mills were: International Paper Co., Research Div., Glens Falls, N. Y.; Finch, Pruyn & Co., Inc., Glens Falls, N. Y.; The Diamond Match Co.,

Plattsburg, N. Y.; The Newton Falls Paper Co., Newton Falls, N. Y.; J. and J. Rogers Co., Au Sable Forks, N. Y.; Imperial Paper and Color Corp., Plattsburg, N. Y.; and West Virginia Pulp & Paper Co., Mechanicville, N. Y.

All committee members are to be congratulated on a fine job.

Committee Members

Chairman, R. M. Drummond

Technical Meetings	R. H. Wiles and C. N. Hagar, Jr.
Reservations and Finance	R. N. Prince and G. Hocking
Mill Visits	R. D. Moynihan
Publicity	C. Davis and P. Haggerty
Social Events	John Crocker
Men's Golf	J. Tipka
Ladies' Events	Mrs. R. M. Drummond
Ladies' Bridge	Mrs. Ralph Prince
Trap Shooting	H. D. Cook and E. N. Zoeller

CLYDE DAVIS, *Secretary*

Semichemical Pulping of Hardwoods

H. L. Field

THE topic of this paper is concerned with another milestone in man's historic search for a more abundant and less expensive raw material for making a paper product. For many ages this search met with relatively minor success until about the middle of the 19th century.

Then, within a few years, several processes were developed for the pulping of the plentiful stands of coniferous woods which covered vast areas of this country and the rest of the world. At last the search appeared to be over.

However, it was not long before the great industrial boom, created in part by the development of these new processes, caused such a heavy cutting of our coniferous forests for both pulp and lumber, that it was soon obvious to many that the use of coniferous woods was only a partial answer to the fibrous raw material problem.

In the short space of less than four generations a considerable portion of the great virgin coniferous forests of the Northeastern and North-Central United States has been consumed. Pulp producers in these sections have continuously been looking farther from home for their coniferous wood supplies, and the consumption of the southern pine forests is fast overtaking their rate of growth. This is also true of the more accessible areas of the giant forests of the great Northwest. Yet the industrial boom and its ever increasing demand for lumber and paper products continues to grow with only minor hesitations, at an ever accelerated rate.

There are few remaining territorial frontiers for additional wood supply which can be explored in order to satisfy the appetite of this growing giant we call our industrial economy, and these few are increasingly inaccessible and costly to utilize.

The frontiers of today and tomorrow lie in the better utilization of our present fiber resources. Many steps have been taken in this direction by the pulp and paper industry. Among these are the increased use of fiber wastes, the use of coated papers for more purposes, increased use of groundwood in some paper grades, and progress in the development of processes for the use of fibrous agricultural residues. However, strides of far greater practical significance, especially in the Northeast, have been those involved in increasing the yield of product from the wood, and in developing processes which produce pulps of high utility from the abundant quantities of hardwoods, which, until recently, were of little industrial importance. Prominent among these developments are the adaptation of the full chemical kraft process to the use of hardwoods, semichemical (sometimes called "high yield") kraft, the high yield sulphite process, chemigroundwood, cold soda, and the oldest and most prominent in this new field, the neutral sulphite semichemical (NSSC) process. The last is the one with which I am most familiar, and I will confine most of my subsequent remarks to those which apply to this process.

It would be well first to give a good definition of this new class of pulping labeled semichemical, as applied to all such processes, including that in which sodium sulphite is the principal chemical pulping agent. Semichemical pulping is that of selectively softening and/or partially dissolving all or most of the cementing lignin in a lignocellulosic raw material by a mild treatment with a chemical agent, followed by a reduction by abrasion and attrition to a pulplike material into which the individual fibers are liberated in a relatively undamaged condition. This contrasts with the conditions of chemical pulping in which the cementing lignin is substantially completely dissolved so that little or no physical effort is required to fiberize the cooked chips, and also those of mechanical pulping, where substantially all of the fiberizing is accomplished by physical action. In the former class of pulping considerable chemical damage is imparted to the cellulosic portion of the wood, while in the latter, severe physical damage is incurred. Therefore, it is reasonable to conclude that the proper application of semichemical pulping potentially makes the strongest possible pulp of a given purity from any given raw material.

The history of the NSSC process including its original development in the early 1920's by the United States Forest Products Laboratory, its early utilization for pulping straw, as well as for pulping chestnut and oak chips which had been extracted of tannin, and its improvement and extension to include the production of good grades of both unbleached and bleached pulps from hardwoods, have already been reported in detail in the literature.

To date it has not been economically practicable to make a pulp of medium or high cellulosic purity from coniferous woods by any semichemical process. Therefore, the use of coniferous semichemical pulps has been limited to the production of unbleached products ranging from rough boards to high-grade unbleached wrapper and envelope stocks. A few pulps of relatively poor quality have been produced from some of the less resinous conifers by the NSSC process.

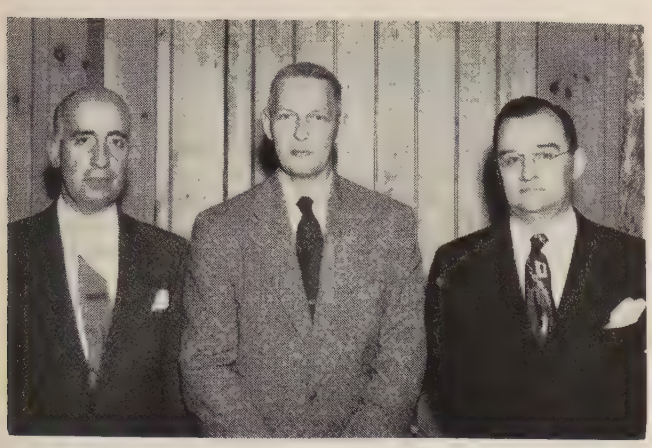
This process is particularly adaptable to the pulping of hardwood species of low and medium lignin content. The first successful higher quality pulps were made from poplar and aspen. More recently beech, birch, maple, southern gum, and some of the oaks have shown great promise in the production of good grades of pulps for unbleached, semibleached, and fully bleached papers. The greater density of these latter species is of considerable interest because of the possible increase in yield of pulp per cord.

Pulps of good strengths and high yield are attainable from wood of good quality. Rotten wood and wood stored for excessive periods produce pulps of poorer quality and lower yield. However, a short period of storage, especially in peeled condition, is not considered detrimental.

The necessity of barking the wood for use in the NSSC process varies with the end use of the product. The whole substance may be cooked in the production of some rough board-type pulps, but for high grade paper pulps, it is considered essential to use partially or fully peeled wood. Much of the fibrous and corky bark tissue can easily be detected in the paper as dark shives and granular bark specks. This material is also extremely difficult to bleach. Some of it can be eliminated or made less objectionable by proper cooking, fiberizing, and pulp cleaning, but a considerable quantity will remain in the pulp. Therefore, it should be removed from the wood if a pulp of good appearance is to be obtained.

The peeling of the heavy hardwoods, especially in the North, is a difficult problem. No easy solution is forthcoming at this time. They are difficult to sap peel, and the peeling season is very short. Farmers are busy at agricultural work during this time of year, and woods labor looks on this job

H. L. FIELD, Technical Supervisor, West Virginia Pulp and Paper Co., Mechanicville, N. Y.



R. M. Drummond, International Paper Co.; D. C. Mather, Carthage Paper Makers; and R. N. Prince, J. & J. Rogers Co.

with little taste. Most rossers and hydraulic barkers are not able to handle the more crooked sticks of the hardwoods. Hydraulic barkers have generally been difficult to adapt to the varied sizes and peelability of the hardwood logs. Drum barkers are in use, but they are low in capacity. Drum barking can be combined with chemical debarking techniques. Air jet flotation methods of removing bark from the chips have been designed, but as yet there is little commercial experience to determine the extent of the separation.

The chip quality requirements in the production of a pulp of good appearance generally specify small chips with a minimum of oversized and undersized material. An average size of between $^1/_2$ and $^5/_8$ in. is recommended. However, a slightly larger chip may be tolerated if young wood is used, theoretically if all species containing tylosic formations are avoided, and if at least a moderate period is available for penetration of cooking liquor into the chips. This may be important where the capacity of a chipper would otherwise be limited, or where sawdust losses are excessive.

Where a high grade of pulp is desired, and little time is provided for liquor penetration, such as in most continuous pulping processes, or where the woods used contain tylosic formations, it is essential to supply the smaller chips.

The use of proper methods in the cooking process is a large factor in determining the character of the final pulp. The batch method of cooking is used in both stationary and rotary digesters to produce products ranging from coarse board pulps to those suitable for the better unbleached grades, or for bleaching.

The continuous method generally produces a coarse product, but considerable progress has already been made in the production of bleachable semichemical products in continuous digesters. Some sort of continuous digestion will undoubtedly be the ultimate method in all chemical or semichemical pulping processes. However, although several experimental continuous processes for producing high-grade pulps are now being studied, to my knowledge, no large commercial installation is yet in operation.

The conditions which govern the penetration of the cooking liquors into the chips are most essential to the production of a pulp of good quality. Since the pulping process is dependent upon the softening and partial solution of the wood's binding materials by the chemical agent, it is first necessary that the needed amount of chemical be equally available to each particle of wood substance so that the extent of the reaction on each is substantially equal. It is also necessary, according to one theory explaining the necessity of good penetration, that the chemical, including both the anion and the cation, be available below the critical polymerizing temperature. If only the more mobile ion is available, a dark-colored polymerized complex is formed between the lignin and this ion. This complex is relatively unreactive to further chemical treatment, and results in chips containing darkened or "burned" centers.

The penetration of chemicals into most northern hardwood chips occurs at a relatively rapid rate in the sapwood when the temperature is maintained just below the critical level. In the heartwood, however, the rate is often retarded by extraneous materials which are deposited therein. Penetration is also drastically retarded by tylosic formations which are found in the heartwood of some species and the whole wood substance of others. Where high quality pulp is needed, it is therefore necessary to maintain a long enough penetration period to reach the center of the slowest penetrated chip.

Within the last few years much of the efforts of several research groups have been devoted to the reduction in the time required for proper penetration.

Methods of pretreating the chips before their introduction into the digester have been studied as aids to solving the penetration problem. Among them is a prepenetration of liquor into the chips at about 95°C. in an open vessel before they are charged into the digester. Others include ways of breaking or "opening" of the chips in a hammermill or similar equipment in order to reduce their effective size. In other systems the chips are squeezed and crushed in a screw press after which they are discharged directly into a stream of hot liquor. The crushed chips act like a sponge. Tests have shown that the physical action of smashing or crushing the uncooked chips damages the fibers therein, so that there is a reduction in the maximum potential pulp strength available from the particular wood. However, with careful regulation of the conditions of the treatment, these losses can be minimized, and a pulp with very good strength properties can be produced.

It has been found that the rate of penetration in the digester is considerably increased by the application of high static pressure, preferably hydrostatic, during the treatment. The recommended pressure ranges from about 125 to 220 p.s.i. It is also possible to increase the rate of liquor penetration by subjecting the chips to a vacuum of about 25 to 28 in. Hg just prior to the introduction of the liquor. Another aid to penetration is that of presteaming the wood chips in the digester and then charging cold liquor thereto. The air in the chips is expelled, and replaced by the steam which condenses as it is cooled by the liquor. The liquor is drawn into the chips by the partial vacuum which is created. Some investigators report that as much or more penetration is obtained by extending the pressure penetration period over the period which would be occupied by the pre-evacuation or the presteaming phase.

Some batch cooking techniques require that the excess liquor be blown from the digester just after the penetration period is completed. This feature results in the saving of considerable steam, and can make possible some reduction in the cooking time.

A contrasting theory claims that the excess liquor should remain in the digester because its presence around the chips during the cooking reaction increases the uniformity in the degree of cooking from chip to chip and from batch to batch, especially, if a mixture of species are being cooked together. The liquor capacity as well as the demand for chemical differs from chip to chip. Uneven treatment results where there is no liquor medium in which the chemicals may readily migrate from a chip of low chemical demand to one requiring more, and where reserve chemicals are unavailable in the liquor. The proponents of the latter theory are content to sacrifice some cooking time and steam in order to obtain better uniformity and reproducibility of product.

After the liquor has penetrated into the chips the temperature may be raised as rapidly as possible to that desired for cooking. A perceptible reaction between sodium sulphite and the lignin begins at about 120°C. and the rate increases in geometric progression, doubling for about every 10° increase.

G. D. Hughson, Canadian International Paper Co.; R. M. Husband, College of Forestry, State University of New York; R. H. Wiles, International Paper Co.; H. L. Field, West Virginia Pulp & Paper Co.; and L. E. Walkup, Battelle Memorial Institute

Sodium sulphite is a very mild pulping agent compared to chemicals used in the sulphite or kraft process, and its action is more selective on the lignin in the high yield pulping ranges. This low pulping potential results in a much greater insensitivity to changes in the pulping conditions during the cooking phase.

The chemical concentration need not be minimized as in other processes for fear of seriously degrading the cellulosic components of the wood unless the temperature of the reaction is far above those normally used for pulping. In fact, there is some evidence to indicate that the selectivity of the reaction between sodium sulphite and lignin is increased with an increase in the concentration of the chemical, if an excessively high reaction temperature is avoided.

There is evidence that selectivity is also increased to some extent as the temperature of reaction is reduced, but it is doubtful whether the difference would be measurable below 160°C. Below this temperature the reaction rate in the cook is drastically reduced so that excessive amounts of time are required to produce a pulp delignified enough for economical production of a fully bleached pulp. It is considered feasible to increase the temperature to as high as 175°C. without seriously reducing the selectivity of reaction on the lignin. The reaction rate is thereby increased, and the time for cooking reduced to some extent. There is some evidence that the lignin in pulps produced at temperatures in excess of about 180°C. is less reactive to chlorine. There are indications that such pulps are more difficult to bleach than those produced at lower temperatures.

The most desirable pulp for bleaching is one from which bleached pulp of desired qualities can be produced, and has the highest yield at any particular chlorine demand.

In cooking for an unbleached product it is important to derive a maximum yield of pulp of the grade desired. The highest efficiency in producing a pulp of this type is realized by obtaining the greatest possible softening of the chips while minimizing the extent of reaction. A reduction in the cooking temperature below 160°C. might therefore, be desirable for many grades of unbleached pulp. Little is known of the factors which influence chip softening during the cook, and tests to measure this quality are just being developed. There is considerable evidence to indicate that the softness of the chips cooked to a given yield has a profound effect on the shive content and the strength properties of the fiberized product, and, to some extent, on those of final bleached pulp.

There are multitudinous factors in the wood, its cooking, the cooked chip handling, and the fiberizing operation which affect the strength and brightness qualities of both the unbleached and the bleached pulps. Time does not permit a detailed discussion of all these factors. However, it is considered expedient to qualitatively acknowledge their existence and to point out a few sample observations: (1) the amount and nature of the native color bodies in each species of wood have a considerable influence on the brightness of the unbleached pulp. (2) The unbleached brightness is increased by a reduction in the pH of the cook. A lower pH is obtained by reducing the amount of buffer to that which is essential to prevent corrosion in the digester and liquor handling equipment. (3) Methods of reducing the amount of air in the digester, such as presteaming, pre-evacuation, and impregnation under hydrostatic pressure, aid in improving this brightness. (4) Lower cooking temperatures (130 to 160°C.) generally cause an increase in brightness at the expense of some pulp strength. (5) The reacted lignin is easily oxidized, especially at high temperature. The unbleached brightness may be increased by minimizing the contact of the cooked chips or pulp with air. (6) As much as 5 points higher brightness have been observed in a properly fiberized pulp as compared to one which was improperly prepared.

Several different techniques have been devised for handling the chips between the digesters and the fiberizers. Few such systems are designed to maintain the cooked chips at an elevated temperature and to minimize contact between chips and air. The advisability of the latter feature has already been explained. The feeding of chips to the fiberizers at a uniform controlled elevated temperature (between 85 and 95°C.) causes a reduction in the power required for fiberizing and an improvement in the appearance and strength values of the resulting pulp. Some systems merely provide for reheating the chips with hot dilution water or liquor as they enter the fiberizers. However, with this method there is usually insufficient time for the interior of the chips to become warmed, and the system is not considered to be effective for this purpose.

Although the types and condition of the woods used, the conditions incurred during the cook, and the method of handling the cooked chips have a marked effect on the characteristics of the final product, the key to any semichemical process lies in the proper adaption of the fiberizing operation. The major variables in fiberizing which affect the qualities of the resulting product are: (1) the properties of the material to be fiberized, (2) the type of fiberizing equipment, (3) the design of the fiberizing surfaces, (4) the shear speed between these surfaces, (5) the amount of power expended in fiberizing, (6) the consistency between the fiberizing surfaces, (7) the effective temperature entering the fiberizing zone, (8) the clearances between the surfaces, (9) the effective area of fiberizing, and (10) the throughput rate.

The evaluation of these factors is truly in its infancy. Unfortunately, in most instances a good evaluation of the effects of most of these factors on a commercial product can only be gained during closely controlled extended runs in commercial equipment. Under optimum commercial conditions it sometimes takes as long as a half hour to adjust the machine to the desired testing conditions, and some conditions are only feasibly obtained in commercial equipment. In addition much of the information cannot be derived by logical deduction alone, but must be based on information obtained by the slower, tedious, less scientific trial and error methods. Therefore, most of the variables and their interrelationships as controls to the fiberizing operation cannot be studied effectively with small quantities of chips in scale models in a research or development laboratory.

The large cost of commercial pulping and fiberizing machinery has slowed down progress in evaluating and comparing the various designs of commercial fiberizing equipment. The single rotating disk fiberizer and the double rotating disk fiberizer have enjoyed the widest acceptance in the industry. However, the fiberizing action which is characteristic of the curlator, the kollermill, the Claflin refiner, or some sort of modified jordan might be the basis for the ultimate fiberizer.

Although a single-stage fiberizing operation is the most

common in the industry, a few two-stage systems have been installed and many others have been suggested. Some specify a double treatment on all the stock before screening with or without an intervening wash, while others call for a second treatment on only the rejects from the intermediate screening operation. A preliminary shredding of the chips in a breaker trap, a screw press, a drubber, a jordan, or a Dynapulper has also been specified as a preliminary treatment before the regular single or double-stage operation. The shredding treatment is effective in reducing the total power for fiberizing and in improving the control of the main operation. It is doubtful whether a more elaborate fiberizing process is justified in view of the excellent results attainable by the proper application of the fiberizing factors to even the single-stage operation with, or even without, the shredding pretreatment.

Methods of testing the fiberized product for production control purposes are far from adequate. The freeness test and an inspection through a suspension of pulp on a blue glass or through an inspection sheet are most common. Pulp strength evaluations and classifications can be undertaken during more involved studies, but they are not adaptable as guides to production control nor are they correlatable to the tests available for control during the operation. Thus, most of the conditions controlled during the operation, such as power input, throughput rate, plate clearance, consistency, and temperature must be based on information established during the more exhaustive studies. Comparisons of fiberizers and fiberizing plates must also be undertaken during these studies. The complexity of the whole subject suggests that it will always be a subject for considerable discussion.

It would, therefore, be presumptuous of me to attempt a comprehensive discussion of this subject. However, a few additional remarks concerning some of the variables would be appropriate. For instance, (1) a high peripheral shear speed in the disk fiberizer is desirable if a well-deshived pulp is required. Presumably a liquid shear is developed at high speeds which tends to disperse the dirt as well as to fiberize the more stubborn shives, at the expense of somewhat increased power for fiberizing. (2) The size of the disk and its design influence the effective area for fiberizing. The more gradually chips are reduced to pulp, the less is the resulting damage to the fibers, provided that the amount of effective power applied is not varied. (3) Treatment of the chips at medium to high consistencies also generally results in a better fiberized pulp than that at low consistency. (4) The factors of power input, plate clearance, and throughput rate must be balanced to produce the desired product. Plates that run at close clearances cause cutting of the fibers while large clearances cause the by-passing of many partially treated chip fragments (shives). Production at maximum power input rate or maximum throughput rate is seldom advisable where quality of product is a significant factor. However, an approach to both these goals is desirable. This can only be gained by designing the fiberizing equipment to meet the requirements of the mill.

The fiberized product is usually washed and possibly screened. The washing operation is a more or less conventional operation and will not be discussed here. Where screening is considered desirable, both the rotaries and the flat beds have been used with indifferent results. Neither appears to be particularly effective in removing more than the coarser shives, knots, and by-passed chips. If the cooking and fiberizing conditions have been maintained to produce the cleanest product, it is doubtful whether any great emphasis need be placed on the screening operation. Where further pulp cleaning is required a centrifugal separator is probably more effective than a screen.

Several techniques have been adopted for bleaching NSSC pulp. The most prominent of these are the single-stage oxidation bleach and a three-stage sequence including a chlorination, a high density hot caustic extraction, and a high density hypochlorite treatment. My experience has been mainly directed toward the latter process, so I will limit my remarks to those which apply to it.

This type of bleaching is actually a continuation of the pulping process. The lignin is further being selectively dissolved under conditions which are more selective on the lignin than those in a continuation of the cooking phase. By the proper choice and control of the conditions in the cooking and bleaching, the reaction on the cellulosic fraction can be minimized so that an increased yield of a relatively pure pulp of high whiteness and strength can be obtained from any particular wood source.

Although this bleaching sequence is similar in many respects to that of a typical sulphite system, the controls in the NSSC bleaching are much more critical, and therefore, must be much more rigorously maintained. For instance, the degree of chlorination must be under unusually close control. Seemingly minor changes in the bleachability of the stock, or small fluctuations in the throughput rate in a continuous bleachery produce variations in the degree of chlorination, which, in the sulphite system would be almost unnoticed, but in the NSSC sequence cause variations in the partially bleached pulp which cannot be remedied later in the process. The throughput rate may vary because of volumetric fluctuations in flow through the metering system or a subsequent surge tank, or because of variations in consistency. In addition, the maintenance of the proper chlorination temperature and rate of chlorine addition for the prescribed pulp throughput rate are also important.

In the continuous extraction and hypochlorite stages, the towers should be designed for adequate retention time and minimum channeling. Important for control are such factors as temperatures, pH, alkalinity, and good control of both the pulp and chemical charging rates. It is also necessary to obtain high washing efficiencies on all vacuum filters throughout the process.

There is little new to be said at this time about the recovery of cooking chemicals. Several processes have been developed in the laboratory, and two or three are now in the advanced stages of pilot plant and semicommercial development. Chemical recovery is the greatest obstacle to a more universal acceptance of the NSSC process, but I believe the time is not far off when this hurdle will be passed. After this trial is won, it is reasonable to predict that there will be mushrooming of pulp mills using the NSSC process. The research frontiers of today will be the production crossroads of tomorrow. The semichemical method, of which the NSSC process is a prominent example, is truly a new class of pulping. In the evolution of the pulping industry it is highly probable that eventually some form of this new class will virtually replace the conventional full chemical class of pulping in its present forms.

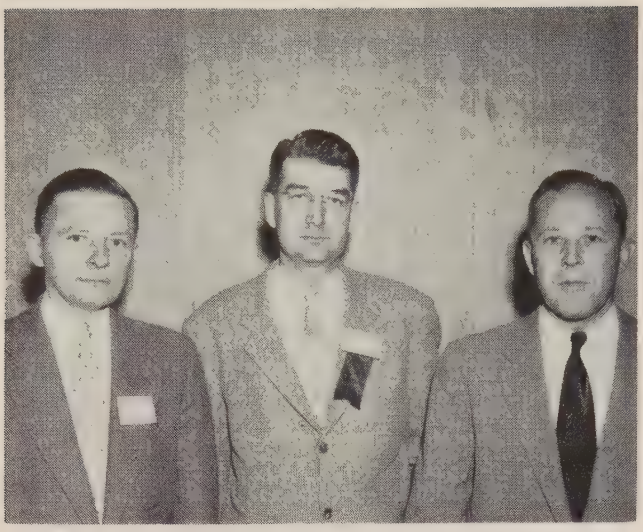
Masking Air-Borne Malodors—Utilization of Aromatic Chemicals in Industrial Odor Abatement

Breckinridge K. Tremaine

You are members of a technical association which constantly seeks to improve not only the products from your plants but the working conditions of operations. Consequently, the problem of malodors which may pollute the atmosphere directly or indirectly is important in your practice of good plant housekeeping. Today we shall try to tell you of a new chemical tool which can be used in abating malodors which may become air-borne.

We refer specifically to the use of industrial odorants, now available from numerous sources under equally numerous trade names. Many of these products are the result of com-

Breckinridge K. Tremaine, Technical Representative, Organic Chemicals Dept., Dyes and Chemicals Div., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.



E. L. Rastatler, The Bauer Bros. Co.; C. H. Hager, Jr., Diamond Match Co.; and B. K. Tremaine, E. I. du Pont De Nemours & Co.

pounding perfume materials such as various essential oils themselves. They may have a place in the odor-masking field such as imparting in place of a malodor a distinctive odor perhaps described as floral, fruity, bouquetlike, etc. However, the new industrial odorants, and the types we shall speak about today, are only indirectly related to the perfume field. They are specially designed products to meet specific chemical requirements. As raw materials they consist of various organic products or by-products. It is their vapor pressure, specific gravity, molecular weight, alkaline or acid stability, solubility, intensity or threshold value, pleasantness or unpleasantness that determines their selection.

With carefully processed and blended industrial odorants, we have demonstrated successfully the masking of malodors such as those traceable to volatile sulphur compounds, amines, proteins, aldehydes, phenol, or chlorinated solvents, etc. More specifically, such odorants are in current use by manufacturers of fertilizers, kraft sulphate pulp, resins, rubber products, petroleum products, and other products of chemical manufacture.

The importance of industrial odorants as a means of abating malodors is, thus, not to be discounted. An even wider acceptance of such odorants has occurred by those who have utilized the masking qualities of such chemicals to improve or reodorize their products. To illustrate, it can be stated, without hesitation, that much of the improvement in odor of foam pillows, sponge mattresses, vinyl fabrics, some resins, and petroleum products is the direct result of the utilization of specifically designed odorants. However, we shall not enlarge at this time on the problem of product reodorization for that is a separate field. Our concern today is the masking of air-borne malodors particularly encountered in industrial plant operations, and of which the pulp and paper industry is one of the largest groups.

The problem of malodor release to atmosphere has become increasingly important to industry in proportion to its rapid expansion during the last half century. Proposals for odor elimination or abatement occupy a prominent part in today's literature which testifies to the vast social and economical importance of this subject. The voluminous literature dealing with ways and means to decrease air-borne malodors indicates that if such odors become air-borne, the methods or measures proposed so far have one feature in common; they are dependent on removing or destroying the odors at a definite point of treatment by physical (e.g., scrubbing, absorption) or chemical (e.g., oxidation, chlorination, burning) means or a combination of both. However, this is not always a cure; it often is not practical or as simple as it may sound. The high capital investment involved in erecting equipment, collecting the malodors at one point or of treatment at a number of points sharply limits the application of these remedies.

Our approach to air-borne odor abatement consists of superimposing a compounded odor upon the plant odor and thus masking its offensive nature. It is evident that to perform this work an improved odorant must have chemical stability as often it must resist rigorous conditions of processing.

Likewise, it should have proper and graduated volatility to complete its travel through an operation or to be carried to atmosphere in proportion to the malodor itself. Most important, it must have, at economical low concentrations, sufficient odor strength to modify noticeably the malodors present. In studying the probability of success in this sphere of reodorization or abatement, we believe it is of utmost importance for you to realize that the odor effect desired to be achieved is a subjective, qualitative impression upon the nose and the olfactory reception, and organoleptic analysis does not follow clear-cut quantitative rules. If there is 1 lb. of malodorous substance to be reodorized, it does not at all follow that in order to achieve a sufficient modification of odor there is needed a pound of masking odor of equal intensity.

Skillfully chosen, a small percentage of a selected compounded chemical preparation may satisfy the sense of olfaction. Time does not allow me to provide you with more details in odor perception, or laboratory procedures such as the use of odor-free water, temperature, aging, requirements, etc., but we do feel it important to include some laboratory background before proceeding with the practical aspects of malodor control, particularly with the pulp and paper industry.

We first start determining if we can mask a malodor by measuring its intensity as well as that of suitable odorants. Odor measurement in absolute terms is not possible because, whether simple or complicated apparatus is used, the odor intensity and quality are estimated ultimately by their perception in the human nose. However, relative odor strength can be determined. The method used extensively in odorimetry is the dilution of clear odorless air with an odorous gas or vapor until the first, often indefinite and vague, odor sensation appears. This amount of odor stimulus is called the minimum perceptible, or the odor threshold value, and it is expressed as the concentration of odorant, preferably in terms of part-per-part of air. This is a yardstick used by many, but we prefer a simpler method based on diluting odoriferous substances progressively in pure water and smelling the air space above the solutions contained in partially filled glass bottles. It became apparent to us that the minimum perceptible or threshold value method of odor measurement, particularly in industrial work, is subject to great error due to the indefinite nature and faintness of the first perceptible odor stimulation. In our procedure, what we call the odor-recognition value is expressed as the concentration of odorant, preferably as part-per-part of water. Such a unit of measurement lies at a concentration about ten times higher than that of the minimum odor threshold value in water itself, and it is much easier to establish and duplicate. Once we have established this odor-recognition value, we proceed semiquantitatively to measure and establish other values which will aid us in final selection of the best product for masking. We then proceed, using the selected masking odorant, to examine its effectiveness in laboratory digester cooks by adding directly into the cook, after loading, usually at concentrations from 1 to 20 p.p.m., based on the total weight of the cook charge, as wood, moisture, chemicals, and steam. This range is used in cooking of pine. In the case of hardwoods concentrations are perhaps higher since we have observed that malodors from such cooks are perhaps more intense. We feel that hardwood cooks require 2.2 times more odorant. Likewise, in cooking flax fibers a still higher concentration of odorant is needed, usually in the range of 40 to 50 p.p.m.

Mr. Meuly, in the paper presented at the Alkaline Pulping Conference last year, covered much of this type of testing.

Recently, confirmation of this work, particularly in the effectiveness of odorants designed for the pulp and paper industry, has been observed in preliminary work which we believe is being followed at the Forest Products Research Laboratory in Madison, Wis.

It has been our observation that laboratory testing, particularly for use in your industry of industrial odorants, is desirable if the proper concentration of odorant is to be used successfully. Such factors as types of wood, time of cooks, temperatures, and particularly sulphidity requirements, will influence the concentration of odorants to be used. More will be said about this later, when observing malodors from organic sulphur compounds such as methyl mercaptan and dimethyl sulphide which in the kraft process are produced as side reactions during the latter part of the pulping operation.

By applying laboratory selection of suitable odorants for masking, we are able to make specific recommendations regarding application by one or more of the following methods: (1) spraying, vaporizing, or atomizing the selected odorant into the air-gas stream; (2) adding directly to a process when possible; (3) adding to scrubbing liquors; (4) spreading or floating on contaminated surfaces without dilution.

In the first instance we are dealing with fumes and gases from exhaust systems, usually a stack or vent system to atmosphere. Spraying, vaporizing, or atomizing a suitable odorant into such a system will usually prove of advantage if the rate of exhaust is below 100,000 c.f.m. If the rate is greater, the results may vary and be unsuccessful. We believe this is because, at the higher rate of exhaust, the malodors become air-borne so rapidly that the odorant injected into the system has insufficient time to cover or perhaps combine, and good control is only possible by using greater quantities of odorant than are economically sound.

Our second point for applying an odorant is directly into a process. Here the odorant must be stable under the conditions of processing. Application may be manual or mechanical. Based on the process requirements, the odorant can be designed to release to the atmosphere with the malodorous gases or be retained in part in the system, eventually becoming either a part of the product of manufacture or passing through in the effluent stage. This practice is now followed in the manufacture of alkaline kraft pulps where the malodors given to atmosphere during blowdowns are largely mercaptans. In these operations it is not unusual to find as much as 1 or 2 tons of malodors becoming air-borne or released in part to streams per daily operation.

We feel confident that many of you have reviewed the literature, which deals directly on the subject of malodors, as prepared by such oustanding men of the pulp and paper industry as Hagglund, Bergstrom, Trobeck, Stephenson, Bialkowsky, Hisey, Tomlinson, and others. Therefore, we shall avoid discussing the broad coverage of malodors, their creation, and concentrations. Instead, we will enlarge on their presence in pulp operations, and why the "Alamask" odorants are best used in a process rather than by any other method of application. Air-borne malodors from operations in the pulp and paper industry are carried to atmosphere from many sources. We have observed their presence in atmosphere from: (1) gas relief during cooking; (2) blowdowns; (3) weak black liquor spillage or runoffs to waste sewers; (4) turpentine recovery; (5) evaporator condensate, their fumes, or the effluents to sewers; (6) from smelters (recovery); (7) from oxidization of black liquors; (8) from lime kiln operations; (9) from lagoons, ponds, settling basins, streams; and (10) from multiple washers.

To control malodors from these numerous points by localized treatment may require special equipment such as sprays, drip devices, perhaps miles of piping, pumps, proportionators, flow rators, etc. Also, many odor points may be difficult to reach and the malodor may differ, both in type as well as intensity.

It was, therefore, necessary to design odorants to cover such malodors by direct addition to the process if uniform abatement was to be secured. The present industrial odorants for use in the paper industry, when specially designed, will reach the majority of these odor points since they do travel through much of the system without imparting odor to the stock or finished product.

The odorant types now in use in kraft operations are designed to release 10 to 20% of their concentration to atmosphere in normal gas relief during early stages of cooking; 60 to 70% is perhaps blown to atmosphere during the blowdown period of release. The remaining 10 to 20% may be carried through and into such operations as pulp washing, liquor recovery, storage, and evaporation. In this latter point evidence of the odorant can be observed in the condensate or effluent stage, or hot liquor at cascades. Likewise, the presence of the odorant from these points may be noticed in sewer outlets to streams. Such coverage of malodors will, of course, vary as to general mill practices and the extent of pollution. However, in general, the major odor sources are odor abated; modified so they are less objectionable if the odorant is used in the cooking operation. Occasionally extra additions of the odorant are required in subsequent oxidization of hardwood black liquor to abate the odor of disulphides which appears to be present. Treatment of ponds, lagoons, or settling basins may, likewise, require additional quantities of odorant.

Our third method of treatment—scrubbing—is another point of application for industrial "Alamask" odorants. They are usually added at low concentrations of 0.001 to 0.01% to scrubbing liquors, such as water itself. For this purpose a soluble type of odorant is used. Waste gases scrubbed with the treated water are quickly changed in odor characteristics and become masked or abated. Likewise, the effluent waste carried to a stream usually contains a proportion of the odorant; consequently, some odor abatement of the effluent itself is possible. This method of treatment of malodors is currently being practiced by chemical manufacturers of superphosphates, processors of fish by-products, manufacturers of vitamins, petroleum by-products, and sanitary chemicals.

The fourth point for application of odorants involves air-borne malodors released from streams and lagoons. The odorant, usually in its oil-soluble form, is applied directly to the stream waste or effluent as it feeds from the industrial operation to sewers. The concentration of a selected "Alamask" odorant, usually sufficient for masking many types of malodors arising from these sources, is 1 to 6 p.p.m. based on the total volume of waste. In other words, 1 gal. of odorant for each million gallons of waste may be sufficient. This type of treatment is now being practiced by firms or industrial plants handling sulphite and sulphate liquors from paper mills; starch and other protein wastes from textile plants; waste products of nitrogenous decomposition from breweries, canneries, and tanners.

There is no doubt that odorants serve an important function in abating malodors from the above sources. They do not, however, influence B.O.D. (biochemical oxygen demand), count one way or the other so far as we have been able to tell. However, their importance to industry, particularly in regard to masking air-borne malodors released directly from wastes in streams or lagoons, should not be discounted because of the lack of influence on B.O.D.

Application of industrial odorants is best accomplished only when all of the conditions covering their use have been fully explored. Each mill's or plant's requirements, conditions of manufacture, waste disposal, and good housekeeping should be studied before recommendations can be made. Toxicity hazards, if any, should be fully evaluated before using an odorant. Also, the importance of mill location, terrain, and prevailing meteorological conditions should be examined.

Mrs. R. M. Drummond and Mrs. R. N. Prince who were responsible for the ladies program

The application of odorants, regardless of the point of treatment and their intensity and chemical nature, is in part influenced, just as is the travel or spread of the malodors themselves, by weather and its many variables. When temperature inversion has become fully established by radiation of heat from the surface of the earth, and turbulence is quite low, malodors remain within a defined area, particularly in dry weather and winds of 5 to 10 m.p.h. Actually, they rise about 100 to 200 ft. and travel downwind in a steady pattern for 1 to 2 miles. Of course, some ground odor is created by turbulence over nearby buildings. The use of odorants during the period of midnight to sunrise is desirable, but with a properly designed product the concentrations required may be small. In the early morning period, solar heating of the ground and the creation of thermal turbulence in the layers of atmosphere bring to the earth's surface malodorous materials that had been confined to the layers above the surface during the inversion period and cause, even in dry or slightly cloudy weather, a general pollution of an area extending several miles downwind. Obviously, this is the time for the use of the right odor abatement compound. After solar heating is in full swing and the midday period arrives, there is a considerably larger volume of air for dilution of malodorous material, and the requirements for an odorant may be less or perhaps eliminated. Later, as we approach the evening period and turbulence is decreasing as solar heating decreases, odor concentration may increase and the use of odor abatement compounds again be logically required.

The above sequence of dispersion events was determined for meteorological conditions of essentially clear, dry weather with moderate wind speeds of 5 to 10 m.p.h. In damp, rainy, humid, foggy weather, the regular use of an odorant may be desirable at the maximum concentrations.

It is our hope that with continued observation and study of weather, the servicing and use of industrial odorants will further aid industry in the search for cleaner air.

The costs of using the "Alamask" odorants when measured against the costs of alternative methods for odor abatement are generally a great deal less. Costs are, of course, dependent on the intensity of the malodors which are air-borne, the efficiency of equipment used, good plant housekeeping, local weather, terrain, and toxicity hazards, if any.

Our pioneering work indicates that fumes from stacks and vents, under preferred conditions, can be reodorized for a fraction of a cent per million cubic feet per minute or in the case of a pulp operation about 10 to 25¢ per ton. Odors from streams can be abated at the source at a cost of perhaps a fraction of a cent per hundred thousand gallons of effluent waste. Reodorization of various products is possible at a cost of perhaps a fraction of a cent to 1¢ per 100 lb. of products.

In conclusion, much progress has been made in the use of "Alamask" odorants; however, there is still need for further study of the present agents and development of improved agents for specific purposes. It is our hope that with continued study and better understanding of various factors, it may be possible to develop improved odorants for masking air-borne malodors.

LITERATURE CITED

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Atomic Power

Edward C. Fuller

The production of useful amounts of power from nuclear fission involves many problems which are common to production of power from any source. First, an adequate supply of potential energy must be discovered; second, this energy must be harnessed in some fashion; and third, the harnessed energy must be hitched to the job to be done. This job may be turning the wheels of machines, heating furnaces or cookers, or electrolyzing mixtures of chemicals to produce new products from raw materials. Since electric power can readily do any of these, our problem is to convert the potential energy of uranium into electricity. Electricity can be generated efficiently by steam turbines driving dynamos. If the "atomic engineer" can deliver the steam, the mechanical and electrical engineer can do the rest. The problem of getting useful power from nuclear fission is summarized, then, by the question "How can we get steam from a nuclear reactor?"

Before anyone builds a steam-electric power plant, he has to find a source of fuel that is plentiful enough and cheap enough to warrant sinking capital into the plant. That atomic fuels are plentiful has been established by mineralogical surveys carried on by the Federal Government and prospecting done by many individuals. The Office of Industrial Development of the Atomic Energy Commission announced in December of 1952 that recoverable uranium is as abundant as recoverable coal. The technology of producing and distributing coal, oil, or natural gas is sufficiently well developed today so that one can estimate fairly accurately the cost of these fuels over a period of many years. Unfortunately, this is not the case with fuels for nuclear reactors. The production of fissionable materials is monopolized by the Federal Government. Because of the terrific military value of such materials, this situation will probably have to be maintained for a number of years. How uranium ores are concentrated and processed to obtain uranium in a form suitable for carrying out nuclear fission is a well-guarded military secret. The amounts of fissionable materials on hand and their cost are known only to officers of high rank in the military services and the AEC. The private enterpriser, then, can enter the field of atomic power production only if the Federal Government will sell or lease its nuclear fuels at a cost which is guaranteed to go no higher for a considerable number of years. A bill to permit sale or lease of nuclear fuels was proposed to Congress by the AEC on May 26, 1953. Let us assume that it will be passed and turn to an investigation of the technical problems of using this fuel to generate steam.

In order to start, regulate, and extinguish a fire in a conventional boiler with maximum utilization of the fuel and mini-

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mum damage to the furnace, the combustion engineer needs to know a good deal about the chemical and physical behavior of his fuel during combustion and the physical problems of transferring the heat produced by the fire into the water in the boiler tubes. He must also be concerned with minimizing wear and tear as well as corrosion by the proper design of the boiler and the selection of the proper materials of construction. The atomic engineer is faced with the same problems but in more acute form because he cannot draw upon an immense backlog of technical knowledge built up from studies of previous installations.

Let us consider first the problem of starting, regulating, and extinguishing a "nuclear fire." Atoms of uranium, like atoms of all the chemical elements, are made up of electrons, protons, and neutrons. Electrons are fundamental particles of *negative* electricity. The mass of an electron is extremely small—about one two-thousandth of the mass of a single atom of hydrogen which is the lightest element. A proton is a particle having a *positive* charge equal in magnitude to the charge of an electron. The mass of the proton is about equal to the mass of the hydrogen atom. Since a hydrogen atom is composed of one proton and one electron it has no net electric charge.

All atoms heavier than hydrogen are constituted of neutrons as well as protons and electrons. Neutrons have no electric charge and a mass about equal to that of a proton. The neutrons and protons are jammed together in a very tiny, positively charged clump called the nucleus of the atom; the electrons swarm around the nucleus forming a kind of cloud of swirling negative electricity which is relatively dense near the center but which fades out toward the edges.

For some mysterious reason, the jamming together of protons and neutrons results in a nucleus which is only about as large as an individual proton, neutron, or electron, all of which have about the same diameter. Because like electric charges separated by ordinary distances repel one another (though this seems not to be the case when protons are jammed closely enough together to form an atomic nucleus) the electron clouds of adjacent atoms in a solid or liquid element do not interpenetrate and the elements may be thought of as like raisin Jello. The positively charged nuclei (raisins) are embedded in a regular pattern in a more or less continuous but very tenuous cloud of negative electricity (the Jello). However, it's a long way between raisins because the diameter of an atom is 100,000 times the diameter of its nucleus. If we assume a raisin is a quarter of an inch in diameter, a helping of Jello 2000 ft. in diameter would have one raisin in it! Matter is mostly empty space.

Ordinary chemical reactions take place between atoms of different elements by the sharing or transfer of electrons moving in the fringes of the electron clouds around the nuclei. Chemical reactions have no effect on the nuclei themselves. These changes in electronic distribution are always accompanied by either the liberation or the absorption of energy. When the carbon and hydrogen atoms of a fuel unite with the oxygen atoms from the air, the sharing of the electrons between carbon and oxygen in carbon dioxide and between hydrogen and oxygen in water liberates heat. It is fairly easy to bring atoms together to make their electrons take part in chemical reactions, but when you're trying to hit an atomic nucleus with another particle of about the same size to get a nuclear reaction, it's like trying to hit the one raisin in a 2000-ft. bowl of Jello with a raisin-sized bullet. The job gets a bit more difficult!

Obviously the easiest way to hit the raisin is to use a machine gun and spray the whole bowl full of bullets. Then you would have a good chance of making the bull's-eye required. This is fine if you have plenty of atomic bullets but unfortunately their cost is very high so you can't use this method if money is any object in your gunnery.

The uranium brand of raisin Jello has two kinds of raisins in it. One hundred thirty-nine out of every 140 nuclei consist of 92 protons and 146 neutrons jammed together in each nucleus while the remaining 1 of the 140 nuclei contains 92 protons and 143 neutrons. The more abundant nuclei are called U-238 and the scarce kind U-235. These scarce nuclei have a most peculiar property—a property which they have in common with the atoms of only two or three others of the 98 elements now known. If a single neutron can be shot into a U-235 nucleus, it upsets the forces holding the nucleus together and three important things happen simultaneously: (1) the nucleus splits into two fragments of roughly the same size, (2) two or three neutrons with high velocities are liberated, and (3) an enormous amount of energy is released—several *million* times as much energy as that produced by the chemical reaction of an atom.

In a piece of ordinary uranium metal, the newly liberated neutrons fly out from the piece with little chance of encountering another U-235 nucleus. (Remember that it's a long way between raisins and only one out of every 140 raisins is a U-235 nucleus.) In a piece of uranium that is made up of U-235 only, there is a better chance that one of the neutrons liberated by the splitting of one atom will collide with another U-235 nucleus and split it, a repetition of this process resulting in a steady production of neutrons and energy. This is known as a chain reaction. The larger the piece of U-235, the greater are the chances for the neutrons to maintain the chain reaction. Since each splitting of a U-235 atom produces two or three neutrons, if none is lost, the chain branches again and again. The rapidly increasing rate of splitting produces so much energy that an explosion results, blowing the U-235 nuclei far from one another and breaking the chain of reaction.

Now if you want to build a nuclear furnace that won't blow itself up, you must somehow control the flow of neutrons through the uranium fuel so that you get a steady production of heat from a chain that just maintains itself but does not branch. If you build up a three-dimensional lattice of pieces of U-235 metal and insert into the lattice some movable rods of cadmium metal, which is a very effective neutron absorber, you can control the neutron flow by moving the cadmium rods into the lattice to slow down the reaction or out of the lattice to speed it up. You can greatly improve the efficiency of neutron utilization by including some pure carbon (graphite) in the lattice. The neutrons liberated by the splitting of a U-235 nucleus are moving with very high velocities and tend to fly right by other U-235 nuclei without affecting them. Fast neutrons are not absorbed but are slowed down (moderated) when they pass through carbon and then they more readily split another U-235 nucleus when they encounter it. Thus a nuclear reactor (often called an atomic pile) consists of (1) a source of neutrons to start the chain reaction, (2) a fuel whose atomic nuclei are capable of splitting when struck by a neutron, (3) neutron absorbers with adjustable positions, and (4) a moderator to slow down the neutrons.

In theory, it should be easy to build a nuclear reactor, but in practice, a lot of very peculiar problems arise. First of all, when a U-235 nucleus splits it produces pairs of fragments which are nuclei of other elements. As many as 20 different elements may be formed. As fission proceeds, what was introduced into the reactor as a slug of solid, metallic U-235 disintegrates into a powdery lump of the metal contaminated with many impurities ("ashes") in various amounts. The uranium slugs, therefore, have to be "canned" in metal containers so the fuel doesn't fall apart in the lattice as the ashes form. The reactor gradually declines in efficiency as the ashes accumulate. Eventually, the cans must be removed from the pile and their contents processed chemically to recover the remaining fuel. Since the ashes give off intense radiations (like those from radium) which are very dangerous to human beings, all the highly complicated operations of chemical processing must be done by remote control with the operators shielded by thick barriers of lead or concrete. For the same reason, the reactor itself must be heavily shielded.

Furthermore, a nuclear reactor must contain structural members to support the various components of the lattice but the structural materials must not absorb neutrons or they will stop the chain reaction. Unfortunately, iron and copper (and their alloys, steel and brass) are effective neutron absorbers so they cannot be used. Magnesium and aluminum are poor neutron absorbers but lack the structural strength needed or become corroded when exposed to the intense radiation in the reactor. The search for a good structural material finally led to zirconium metal which, *if very pure*, is a poor absorber of neutrons, has high structural strength, can be readily fabricated, and resists corrosion. The production of large amounts of zirconium of the high purity required has necessitated years of research and development which culminated in the building of five different industrial and Government plants which together will produce around 200 lb. of the metal per day by the end of this year. During World War II, the cost of high purity zirconium was about $450 per lb. Today, it costs about $13 per lb.

If you want to get steam out of a nuclear reactor to drive a turbine, you run into similar problems. Water is a good neutron absorber so you can't circulate it through the reactor to make steam directly. What is required is a coolant which is a chemically unreactive liquid, which does not absorb neutrons, which is a good conductor of heat, and which has a high heat capacity. The liquid must also have a high boiling point so that the heat of the reactor can be extracted at a temperature of several hundred degrees to produce high-pressure steam in the boiler.

The light metals sodium and potassium meet all of these specifications except that of chemical inertness. An alloy of the two metals is a liquid at room temperature and boils at 1500°. This alloy is so reactive chemically that it bursts into flame on contact with air and explodes on contact with water. For this reason, it cannot be handled by conventional valves and pumps which permit slight leakage around movable shafts. A special pump without moving parts is required. Such a pump has been devised. It pushes the liquid through a pipe by electromagnetic induction in much the same way that the copper wires on the rotor of an induction motor are pushed by an induced electromagnetic field.

The AEC has set up a plant at Arco, Idaho, utilizing this alloy as a coolant. The alloy leaves the reactor at a temperature of 660°. Though a poor absorber of neutrons, the alloy does become dangerously radioactive as it passes through the reactor. To protect the personnel operating the boiler, the radioactive alloy from the reactor is pumped through a heat exchanger and back to the reactor in a closed circuit. A separate stream of the alloy is pumped in a closed circuit between the heat exchanger and the steam boiler. Since the alloy in the secondary circuit of the heat exchanger does not become radioactive, only the reactor and the heat exchanger need to be shielded. To minimize the danger of explosion due to accidental leakage of the alloy into the water of the steam boiler, the pipes bearing the alloy are jacketed with larger pipes carrying mercury in the space between the inner and outer pipes.

So far, we have been considering the problem of how to get steam from a nuclear reactor in which pure U-235 is the fuel. When we recall that only 0.7% of uranium as it occurs in nature is U-235 and the other 99.3% is U-238, we can see that there wouldn't be much of a future in developing commercial amounts of power from uranium fission unless we could find a way to produce energy from U-238 also. This has been done.

When a neutron strikes a nucleus of U-238 it doesn't split as does a nucleus of U-235. The U-238 nucleus absorbs the neutron and becomes a U-239 nucleus. This nucleus is unstable and within a few days it ejects two electrons and becomes a nucleus of plutonium-239. Though the masses of U-239 and Pu-239 nuclei are the same, U-239 nuclei contain 92 protons and 147 neutrons while Pu-239 nuclei contain 94 protons and 145 neutrons because the ejection of two electrons from the nucleus converts two of its neutrons into two protons. When a neutron strikes a plutonium nucleus, it splits in much the same manner as a U-235 nucleus so that a chain reaction producing large amounts of energy can be established.

In order to utilize our natural resources of uranium efficiently, we must so design our reactors that the one or two extra neutrons which are liberated during the fission of U-235 and which are not needed to propagate the chain reaction will collide with nuclei of nonfissionable U-238 and convert them to nuclei of fissionable plutonium. Such a reactor will produce more fissionable fuel in the form of plutonium than it consumes in the form of U-235. For this reason it is termed a "breeder reactor."

The reactor at Arco, Idaho, is of this type. A U-235 core about the size of a football is embedded in a mass of U-238 so that neutrons not used to propagate the chain reaction in the core are absorbed by the surrounding mass of U-238, producing plutonium. The heat of the chain reaction is removed by the sodium-potassium coolant as previously described. On June 4, 1953, the AEC announced that the breeder reactor can produce plutonium "at least" as rapidly as it consumes U-235. This tremendous step forward in nuclear engineering also enhances the possibility of converting another nonfissionable but relatively plentiful element, thorium, into fissionable form.

Breeding nuclear fuels is a slow and costly process. A sizable amount of pure U-235 must be separated from the natural metal which contains 0.7% U-235 and 99.3% U-238. This separation is carried out in large installations like the half-billion dollar gaseous diffusion plant at Oak Ridge, Tenn. After 5 years or more in the breeder reactor, the mass of U-238 in which the core of U-235 has been embedded will contain enough plutonium to warrant processing it in very costly and complex chemical plants like the one at Hanford, Wash. Nuclear fuels are likely to remain very expensive for many years to come.

Because the cost of generating steam in the most efficient of modern steam-electric power plants accounts for only about 20% of the total capital and operating costs of producing and distributing electricity from such plants, the use of nuclear fuels is not likely to have much effect on the cost of electric power for many decades except in regions where conventional fuels are unavailable or of prohibitive cost. However, the time seems to be at hand when new legislation should be passed to permit private enterprise to participate in the development of nuclear power for civilian purposes. In the words of Gordon Dean, the chairman of the United States Atomic Energy Commission:

"There is good reason to believe that a demand outside of the Government's own sphere of operations is developing for atomic reactors. It is a commercial demand, an economic demand, and a civilian demand. It seems only reasonable to expect that people outside of the Government be given a chance to work toward the development of reactors to meet this demand.

"The job ahead is a developmental one—a cost-cutting one—the kind of a job that can be done best by skilled people competing with other skilled people who are working toward the same or a similar goal."

Empire State (Eastern)

The final meeting of the 1952–53 season of the Eastern District of the Empire State Section was held May 23, 1953, at Milfrank's Restaurant on the Glens Falls-Lake George Road.

Ninety members, guests, and their ladies attended the annual Ladies' Night. An Orchestra was present for dancing and a number of door prizes were won. Weber and company

put on an entertaining and mystifying collection of acts. The magician was well received by the audience.

Election of officers for the 1953–54 season was held. The candidates were elected unanimously and are as follows: chairman, John W. Crocker, Sandy Hill Iron and Brass Works, Hudson Falls, N. Y.; vice-chairman, Grant Cole, Diamond Match Co., Plattsburg, N. Y.; secretary-treasurer, George H. Hocking, Socony-Vacuum Oil Co., Albany, N. Y.; program chairman, Oscar Anderson, Jr., International Paper Co., Palmer, N. Y.; publicity chairman, Wiliam S. Spiller, Marinette Paper Co., Fort Edward, N. Y.; and entertainment chairman, Thomas McGreen, Research Div., International Paper Co., Glens Falls, N. Y.

John Crocker was acting chairman and thanked the outgoing officers for their efforts.

The cash prizes for the Junior Award papers (presented at the April meeting) were given by R. H. Wiles. William J. Copeland, International Paper Co., Glens Falls, N. Y., received $25 and the opportunity to present his paper at the Empire State meeting at Whiteface Inn, Lake Placid. Kenneth Fischer, A. P. W. Paper Co., Albany, N. Y., won $10 and Edward C. Burns, Sandy Hill Iron and Brass Works, Hudson Falls, N. Y., won $5.

CLYDE DAVIS, *Publicity Chairman*

New England-Maine-New Hampshire

The New England and Maine-New Hampshire Sections of TAPPI held an outstandingly successful joint meeting at the Poland Spring House, Poland Spring, Me., on Friday and Saturday, June 19 and 20. More than 300 Tappimen and guests attended, and ideal weather favored the meeting.

The high lights of the program were the two technical sessions at which the most desirable characteristics of paper for use in offset, gravure, and letterpress printing were outlined; election of officers to serve for 1953 and 1954; golf tournament, fishing derby; the ladies' busy program, and a special style show.

More than half the total attendance arrived on Thursday and enjoyed informal get-togethers, golf and card games. Friday morning was devoted to registration and brief annual business meetings of both Sections at which the new officers and executive committee members were elected as follows.

New Officers

New England Section: chairman, F. S. Klein, Byron Weston Co.; vice-chairman, Gordon L. Benson, St. Regis Paper Co., East Pepperell, Mass.; secretary, R. W. Ramsdell, Hercules Powder Co.; treasurer, H. T. Barker, Bird & Son, Inc.

Executive Committee: Paul L. Haggery, George LaMonte and Son; C. I. Horton, R. T. Vanderbilt Co.; Miss Helen U. Kiely; J. T. Loomer, Robert Gair Co.; Freeman Perry, Chemical Paper Mfg. Co.; C. L. Reece, Whiting Paper Co.; F. L. Simons, Crane & Co., Inc.; George R. Wallace 3rd, Fitchburg Paper Co.

Maine-New Hampshire Section: chairman, Joseph J. Thomas, S. D. Warren Co.; vice-chairman, Arthur E. Jones, Oxford Paper Co.; secretary-treasurer, H. E. Pratt, Pejepscot Paper Co.

Executive Committee: For three-year terms—Henry S. Hooper, Penobscot Chemical Fibre Co.; J. H. Huer, Great Northern Paper Co.; Roland Martin, Fraser Paper, Ltd. They serve with the following who were elected at previous meetings: W. L. Hinds, Keyes Fibre Co.; F. A. Strovink, American Cyanamid Co.; J. B. Calkin, University of Maine; Jack F. Wright, National Aniline Div.; A. E. Bachmann, Missisquoi Corp.; F. N. Sprague, St. Regis Paper Co., Bucksport, Me.

Boxboard Printability

On Friday afternoon, Chairman Joseph Thomas, Maine-New Hampshire Section, called the meeting to order and presented Vice-Chairman Arthur Jones who presided at the first technical session.

H. W. Verseput, of the Robert Gair Co., presented a paper on "Some Things We Would Like to Know About the Printability of Boxboard." In his remarks the speaker said there is some confusion in the boxboard field on this subject due to the fact that boxboard is made of variable stock, with 42 standard grades and a great variety of furnishes, colors, and specifications. Mr. Verseput said that customers are keen about good printing on cartons and that the paper used must give good penetration, have compressibility, a good surface, and lateral porosity. He discussed methods of testing these factors and also new testing methods and instruments now under trial in the boxboard field.

"Printability of Paper for Gravure" was the subject presented by Fulton McArthur of the W. W. Fitzhugh Co. The speaker stated that what the printer looks for in a paper that is to be used in the gravure printing process is plane, 100% absorbency, wettability, extremely uniform moisture content, smoothness, uniform caliper, good formation, absence of abrasive content, properly and tightly wound rolls, uniform roll splices; fine and nonoverlapping fibers.

Mr. McArthur said that in gravure printing paper, the bursting strength is not important but tensile and tear are.

Lithographic Papers

John D. Payne, S. D. Warren Co., gave an interesting talk on "Coated Papers and the Lithographic Process," in which he detailed briefly the functions of the offset or lithographic method of printing and reviewed the development of litho coated paper to keep pace with the ever widening progress of offset printing. He told how, from 1940 to date, both litho paper producers and litho press and ink manufacturers had made good improvement progress during which the following litho paper characteristics were found essential: (1) strength, (2) well bonded, (3) water resistant, (4) free from chemical reaction, (5) moisture content to meet conditions in the litho plant, (6) flatness, (7) square edges, (8) free of foreign matter or dirt, (9) ink reception, (10) sheet characteristics determine type of ink to be used.

Some of the present problems in litho work described by Mr. Payne are scumming of litho plates, alkali effect on the rubber blanket in offsetting, and smudging.

Groundwood Book

Frank Lincoln, of Time, Inc., spoke on "Coated Groundwood Book Sheets as Used in High-Speed Letterpress Printing" and set forth the qualities desired by the printer in this type of stock for magazines. He said the desirable characteristics are mechanical performance, printability, strength, folding quality, sulphite, and kraft fibers of strength. Mr. Lincoln told how *Life* magazine uses paper made from southern pine, western hemlock, and northern spruce. Additional qualities required in this type of magazine printing stock as outlined by Mr. Lincoln were: proper moisture content, no moisture streaks, uniformly good surface characteristics, compressibility, ink receptivity, opacity, and shade.

Mr. Lincoln said that *Time-Life* use proof tests of stock at paper mills which supply their magazines with paper. He said that while the desired characteristics of the paper have been formed, these tests have not yet been placed on set standards.

While the technical session was in progress the ladies enjoyed play at bridge and canasta tournaments which were followed by tea parties.

Following dinner on Friday evening an old fashioned square dance was enjoyed up to the serving of a midnight snack.

Harris-Seybold Movies

Following a TAPPI breakfast at which there was special

entertainment, the second technical session of the meeting opened with a showing of two highly interesting technicolor and sound movies by Joseph C. Doty, Harris-Seybold Co.

The first movie, "How to Make A Good Impression," presented excellently and in brilliant color and comments the offset and letterpress methods of printing, showing the preparation of drawings and text, production of offset plates, and printing color separation in multicolor press work.

The second movie, "A Better Run for Your Money," showed how an advertiser can get more for his money through offset work, proving in animated style that anything that can be photographed can be used in offset printing.

Panel Discussion

Then followed a panel discussion of the subjects presented at Friday afternoon's technical session, the panelists being those who presented the papers at the previous session.

Luncheon was served in The Pines adjoining the Poland Spring House and in ideal weather. Immediately after this event the golf tournament and the fishing derby got under way. With the men folk so occupied, the ladies enjoyed a delightful "Bates Disciplined Fabrics" style show with live models displaying beautiful and highly stylish cotton dresses and sportswear. A tea followed the show.

The closing event of the meeting, the banquet on Saturday evening, featured a deeply interesting address on current national and world affairs by Bill Cunningham, noted columnist of the *Boston Herald* and a radio commentator of national fame. Mr. Cunningham, Dartmouth College graduate of the class of 1921 and an All-American football center of his time, was appropriately presented by C. H. Kent of the Hercules Power Co., a member of the 1910 graduating class at Dartmouth.

J. J. O. Brien, *Paper Mill News*

GENERAL MANAGER

A General Manager is required for the Tasman Pulp and Paper Company Limited of Auckland, New Zealand. The Company, which is one of the largest in New Zealand, has a nominal capital of £6,000,000, some of which has been subscribed by the New Zealand Government. Contracts have been let for the erection of the plant and for the purchase of the major items of equipment. The pulp, paper and sawmills, which will have a capacity of 75,000 tons of newsprint and 72,000,000 bd. ft. of timber annually and 150 tons of kraft pulp daily, will be situated alongside the township of Kawerau in the Bay of Plenty, North Island, twenty miles from the town of Whakatane and within fifty miles of Rotorua and Tauranga. The company requires a man of the highest calibre with a proven record in the management of a large scale commercial enterprise, with the ability to lead and conduct the affairs of the company on the highest level. Previous experience in the pulp and paper industry is desirable, but not essential.

A substantial salary will be paid: duties will commence in New Zealand within twelve months; housing available, and first-class fares to the successful applicant and his family will be paid. Applications will be treated in the strictest confidence and should be made in duplicate to the Chairman of Directors, Tasman Pulp and Paper Company Limited, Private Bag, Auckland, New Zealand, and should be accompanied by copies of recent testimonials and a photograph.

Effects of Chemical Treatment of Pulpwood Trees

D. C. McINTOSH

In the manufacture of pulp and paper it is essential that the pulpwood bolts be free of bark. Most mills producing pulp are equipped with machinery for the removal of bark. This machinery is expensive in initial cost and maintenance. Some mills readily accept peeled wood from local suppliers, or during the season of the year when bark is easily removed, arrange some of their operations to provide for peeling logs in the woods. In Eastern Canada, from early Spring at about the time the leaves appear on the trees until midsummer (May, June, and July), the bark is easily removed from freshly felled trees by means of ordinary hand-peeling tools, such as a barking "spud" or an axe. This process is usually known as "sap-peeling," and the period during which it may be done is called the sap-peeling season. During late Summer and Winter the bark adheres to the wood, and peeling by hand methods is uneconomical. Pulp companies then rely upon barking machinery.

The fact that bark may be readily peeled from trees during the so-called sap-peeling season is explained by the soft texture of the cambium during the active growing period. The cambium, a thin layer of living cells occurring between the bark and the wood of exogenous trees, is responsible for the growth which forms the annual layers of wood and bark. During the season of active growth the cells of the cambium are actively dividing and may be torn readily so that this layer presents a region of easy cleavage which permits clean separation of the bark from the wood. As the yearly period of growth approaches its end, the cambial cells toughen and their consistency is then more nearly similar to that of the adjacent wood and bark. As this change occurs, the bark is not easily separated from the wood and becomes very difficult to remove.

In 1943, at the request of the Canadian Pulp and Paper Association, the Ottawa Laboratory of the Forest Products Laboratories Division began tests in the treatment of trees with chemicals to facilitate removal of bark, a process on which a patent was issued in 1942. The application of appropriate toxic chemicals during the sap-peeling season appeared to kill and fix the bark in the easy peeling condition, and the easy peeling quality that characterized it at the time it was killed was retained. Early tests, on a limited scale, showed also that the wood of some chemically treated trees was lighter in weight than that of normal untreated trees. This reduction in the weight of wood of treated trees appeared to have practical significance from the standpoint of economies in handling, transportation, and improved floatability of pulpwood logs.

Results obtained in early experiments with the process showed practical possibilities, and further tests were undertaken. Various chemicals and different means of application were tried in order to determine which treatments would produce the best results in easy peeling and weight reduction. Tests were designed to ascertain the best season of treating and felling in order to improve the peeling qualities and to obtain the greatest drying without severe de-grade of the treated material.

This report presents a summary of the work done by the Forest Products Laboratory, Ottawa, on chemical aids in bark removal and on the effects of chemical treatment in reducing the weight and improving the floatability of wood, together with observations made on the quality of the wood of treated trees. Experiments which form the basis of this report were conducted at the Petawawa Forest Experiment Station,

D. C. McIntosh, Forest Products Laboratory, Ottawa, Ont.

Petawawa, Ont., at Maberly, Ont., and on the pulpwood limits of Marathon Paper Mills of Canada, Ltd., at Stevens, Ont.

Tests on various pulpwood species at the Petawawa Forest Experiment Station were on a relatively small scale. Different chemicals and methods of application were used, and the tests were conducted from 1943 until 1949. At Maberly, Ont., the work in 1946 and 1947 was in connection with a cedar poles and posts operation. Cooperative experiments with Marathon Paper Mills at Stevens were on a large scale with some 3800 trees of six pulpwood species being treated from June until mid-September, 1947, and felled for testing at various times during 1947 and 1948.

METHODS OF TREATMENT

Formation of the Girdle

The toxic chemicals had to be introduced into the sap stream of standing trees. In early experiments chemicals were applied to trees by boring holes near the base of the tree and filling these holes with chemicals. This method proved unsatisfactory since the chemicals affected the bark only above the point of application and complete killing of the tree was slow. To secure easy peeling of treated trees it was necessary to apply chemicals to the sapwood around the circumference of the tree. This was more easily accomplished by girdling through the bark to the sapwood at a convenient height and applying chemicals uniformly to the freshly exposed sapwood.

To form the girdle in experimental treatments conducted by the Laboratory, two types of girdling tools were used—a double-bladed handsaw and a small hand tool fitted with a V-shaped knife.

Double-bladed handsaw. This girdling saw (Fig. 1) was made by attaching two lengths of bucksaw blade to the sides of a hardwood block about 2 in. wide and 18 in. long and fitted with a handle. As shown in Fig. 2, the saw was operated around the tree at a convenient height, care being taken that the cuts made by the saw at the start and at the completion of the operation coincided. After the saw cuts were made the ring of bark was easily stripped off to expose the sapwood. Figure 3 shows the removal of the strip of bark from the tree girdled in Fig. 2. The blade forming the upper edge of the girdle was adjusted so as to cut through the bark to the sapwood while the lower blade usually extended about half an inch into the sapwood. The deeper lower cut was made so that the conducting cells in at least part of the sapwood where the sap was ascending were severed.

V-tool. This girdling tool (Fig. 4) was fitted with a V-shaped knife which, when pulled against the tree, cut through the bark and into the sapwood forming a shallow and narrow girdle. The size of the girdle (width and depth) depended upon the thickness of the bark and amount of pressure applied to the tool. The tool was operated so that the flat side of the V-knife formed the lower side of the girdle making a shelf to hold the chemicals.

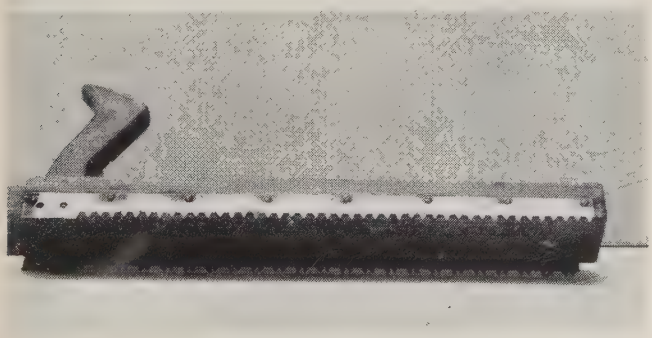

Fig. 1. Double-bladed handsaw used in some experimental girdling

Fig. 2. Girdling black spruce with double-bladed handsaw

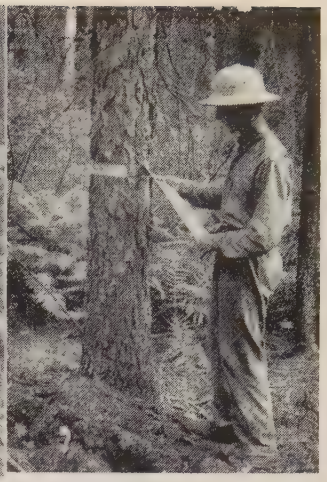

Fig. 3. Removal of strip of bark after girdling with double-bladed handsaw

Axe. An axe, although not employed to girdle trees in experiments under discussion, can be used to form a girdle to which chemicals may be applied. With this type of girdle care must be taken when chemicals are applied in order to ensure a uniform application.

Power-girdling tool. A motor-driven girdling tool, recently developed, is reported to be satisfactory. The current model is somewhat similar to the one shown in Fig. 5. With this machine an undercut is made into the sapwood by a circular saw in order to sever the sap-conducting cells. Dado blades set on the shaft above the circular saw are adjusted so as to remove the bark for about 2 in. thereby forming a girdle of sapwood to which chemicals are applied. In Fig. 6 the power-girdling tool is shown in operation on aspen poplar.

In experimental treatments, the girdle was made at a convenient height above ground (about breast height) to facilitate girdling and application of chemicals.

Application of Chemicals

Chemicals used in the treatment of standing trees must be soluble in water so that they may be carried up the tree in the sap stream. In most cases, chemicals were mixed with water and a small quantity of flour, when necessary, to form a paste. The chemical paste was held in close contact with the sapwood by means of a band of crinkled kraft paper which was pulled tight around the tree at the girdle and fixed in place with a broad-headed upholstery tack. In experimental treatments at Stevens, Ont., where the V-tool was employed to form the girdle, the soluble chemicals in paste form were poured on a strip of crinkled kraft paper as shown in Fig. 7. The bandage was then pulled tight around the tree and fastened in place with a tack, care being taken that the chemicals were in close contact with the exposed sapwood of the relatively narrow girdle. Figure 8 shows a treated black spruce tree which had been girdled with the double-bladed handsaw.

In some instances where it was desirable to record the exact amount of chemicals applied, dry soluble chemicals were placed between the sapwood of the girdle and the protective paper band after the band was fixed in place. Figure 9 shows a band of crinkled kraft paper being placed on a girdled aspen while Fig. 10 shows the dry soluble chemicals being poured between the paper band and the sapwood.

Recent tests have shown that when a chemical of high toxicity (such as soluble arsenic) is used, trees can be successfully treated without applying the protective band of paper. Trees treated by brushing a solution of soluble arsenic on the exposed sapwood of the girdle without the protective kraft

Fig. 4. Girdling tool fitted with V-shaped knife

paper showed peeling characteristics similar to those of trees which had a covering paper band protecting the chemicals.

Application of chemicals to the girdle must be made as soon as possible after the sapwood is exposed. If a relatively long period of time is allowed to elapse, the ability of the tree to absorb chemicals in the sap stream is reduced, apparently because of the tendency of the sapwood to dry at the girdle and because the girdle, in some of the coniferous species with wood characterized by resin ducts, becomes partially coated with resin.

Chemicals Tested

The various chemicals tested, since experiments in the chemical treatment of trees were begun, are listed in Table I.

Table I. List of Chemicals Tested in Treatment of Trees to Facilitate Removal of Bark

Ammonium sulphamate
Arsenic—(A soluble compound of arsenic was made by a mixture of arsenic trioxide with caustic soda. A commercial grade of sodium arsenite was also used with about the same results.)
Cambicide A—(Commercial preparation in prepared rolls of paper bandage, said to be a mixture of sodium chlorate and calcium chloride.)
Cambicide B—(Commercial preparation in bandage as above, said to be chiefly sodium sesquisilicate.)
Copper sulphamate
Copper sulphate
Copper sulphate with sodium chlorate
Ferrous sulphate
Potassium dichromate
Potassium persulphate
Sodium arsenite, commercial
Sodium bisulphate (sodium acid sulphate) granular
Sodium chloride
Sodium chlorate
Sodium pentachlorophenate
Sodium selenate
Sodium tellurate
Sulphamic acid
Trichloracetic acid
Zinc chloride
Zinc chloride with sodium chloride
Zinc chloride with potassium dichromate
2,4-Dichlorophenoxyacetic acid
(Sodium salt)
(Isopropyl ester)
2,4,5-Trichlorophenoxyacetic acid
(Butyl ester)

After considerable experimenting it was found that easy peeling was best secured by the use of various soluble forms of arsenic. Insoluble arsenic trioxide is converted into soluble sodium arsenite by mixing with sodium hydroxide (caustic soda). In experiments conducted at Stevens, Ont., an arsenic paste of high concentration was used, prepared by mixing 1 part, by weight, of arsenic trioxide, and 1 part of a 50% solution of caustic soda with addition of flour to form a thin paste. In other tests, however, the arsenic paste was of lower concentration and was prepared by mixing the following:

Arsenic trioxide	3 parts by weight
Caustic soda—50% solution	1 part by weight
Water (hot)	5 parts by weight
Flour	up to 8% of total weight
Phenol	1%

Tests of the application of the weak arsenic paste mixture appeared to give results similar to those in which the paste of high concentration was used. Phenol was added so that the paste would be unattractive to wildlife.

Water-soluble chemicals such as ammonium sulphamate and sodium chlorate were, in most instances, mixed with a little water so that the chemical could be poured from a container to the band of paper and applied to the girdled tree.

In tests at the Petawawa Forest Experiment Station, various quantities of chemicals were applied so that their relative effectiveness could be observed. For instance, quantities of ammonium sulphamate varying from $^1/_2$ to 3 oz. were applied to trees of pulpwood size while with a chemical such as the sodium salt of 2,4-dichlorophenoxyacetic acid, the effects of amounts of from 10 to 30 grams were tested. Amounts as small as 15 grams (dry weight) of the most effective chemicals, such as soluble arsenic, were found to produce effective results on trees of average pulpwood size.

Throughout the experiments, check trees, girdled but not chemically treated, were observed and tested for comparison with treated trees.

Species Tested

The effects of chemical treatment were observed on nine species—jack pine, *Pinus Banksiana* Lamb.; balsam fir, *Abies balsamea* (L.) Mill.; black spruce, *Picea mariana* (Mill.) B.S.P.; white spruce, *Picea glauca* (Moench) Voss; eastern cedar, *Thuja occidentalis* L.; aspen, *Populus tremuloides* Michx., and *Pgrandidentata* Michx., balsam poplar, *Populus balsamifera* L., and white birch, *Betula papyrifera* Marsh.

Fig. 5. Power girdling tool

Trees treated, with the exception of balsam poplar and eastern cedar, were of average pulpwood size (7 to 12 in. D.B.H.). Balsam poplar trees which received treatment were somewhat larger while the cedar was of pole and post size.

Time of Treatment

In most instances, treatments were applied during the sap-peeling season (May until mid-August). However, some experimental treatments were made in September at Stevens, Ont., and in November at the Petawawa Forest Experiment Station to test the effects of application of chemicals after the normal sap-peeling season had ended. The time necessary to girdle trees and apply chemicals in the experiment at Stevens was recorded.

METHODS OF TESTING

In tests at Stevens, in which blocks of trees of six species were treated with different chemicals in June, July, August, and September, 1947, four or five trees from each group were felled at monthly intervals after treatment until mid-October, 1947, and again at various times during 1948. In other experimental treatments, treated trees were felled after varying periods of time subsequent to treating. After felling, trees were observed for ease of bark removal and occurrence of insect and stain attack. Samples were cut from the trees at 100-in. intervals for information on moisture content, basic density, and weight per cubic foot of peeled wood. Logs from some of the sample trees were used in flotation tests in order to assess the effect of seasoning produced by chemical treatment on the buoyancy of logs. During each cutting period, normal untreated "control" trees were felled and sampled for comparison with trees which had been treated with chemicals or which had been girdled only.

Bark Removal

The ease of bark removal was tested by peeling with a barking spud or an axe. Particular attention was paid to the top logs since the removal of bark in these regions was somewhat more difficult than at the lower levels. Observations on peeling were recorded as being easier than sap-peeling, the same as sap-peeling, and harder than sap-peeling. Notes were also made with regard to the sizes of the pieces of bark removed (i.e., in long strips, in small pieces, etc.).

Insect and Stain Attack

During the process of observing the ease of peeling, notes were made on the degree of attack by bark insects and wood borers, and the color of the sapwood surface. Records of attack by blue stain were made when the trees were sampled.

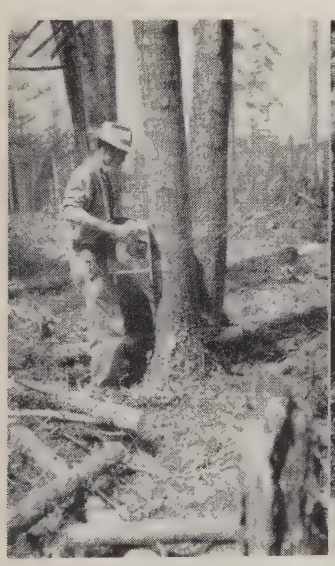

Fig. 6. Power girdling tool in operation on aspen poplar

Fig. 7. Application of chemicals to jack pine at Stevens, Ont. (Note narrow girdle formed by V-tool)

Fig. 8. Black spruce tree with treatment completed

Fig. 9. Fixing kraft paper in place on aspen poplar girdled with double-bladed hand-saw

Determination of Changes in Weight of Wood

Samples in the form of cross-sectional disks from 1 to 2 in. thick were cut at various levels in the trees as soon as possible after felling. In most cases, the samples were taken at the butt (stump height) and at 100-in. intervals above the butt to a point where the diameter was about 4 in. Each sample was peeled and weighed immediately after being cut. Diameters, measured with a diameter tape, were also recorded. The samples were then forwarded to the Forest Products Laboratory, Ottawa, where they were stored in water in preparation for measurement of basic specific gravity.* The volume at saturation was measured by immersing each sample in water on the point of a steel wire, the buoyant force of the water in grams being recorded as the volume of the disk in cubic centimeters.

After measurement of volume, each sample was dried to constant weight in an oven and the oven-dry weight was recorded for use in computing the moisture content of wood as felled and the basic specific gravity.

Flotation Tests

During testing periods in 1947 and 1948 at Stevens, logs from trees treated with different chemicals, logs from trees which were girdled and no chemicals applied, and logs from untreated control trees were floated in order to assess the effect of treatment on buoyancy. Material to be floated was selected from trees which had been sampled for moisture content determination. The logs, 100 in. in length, were placed in the water with bark intact. The "rise" (the mean distance between the water line and the top surface of the ends of the floating log) was then measured. From these measurements the floating margin (the volume, in per cent, above water level) for each log was calculated. The rate of decline in buoyancy was observed in relation to the original floating margin and was indicated by measurement of the "rises" at various times after the logs were floated.

THE WEIGHTING OF TEST DATA

Variations in such factors as basic density and moisture content normally exist in wood from different heights in trees.

* The basic specific gravity is equivalent to the basic density in that it may be read as the weight in grams of oven-dry material per cubic centimeter of wood in the saturated condition.

on normal jack pine trees, for instance, small top logs usually have a higher moisture content than butt logs of large diameter. However, the basic density of wood of butt logs is greater than that of top logs. An example of this normal variation is shown in Table II.

Table II. Jack Pine—Variations in Wood from Different Levels Above Stump

Height above stump, in.	*Diameter inside bark, in.*	*Moisture content, % of oven-dry wt.*	*Basic density, vol. saturated; wt. oven-dry*	*Weight per cu. ft., lb.*
Butt	8.3	96.9	0.409	50.3
100	7.5	90.8	0.396	47.2
200	6.9	93.5	0.375	45.3
300	6.1	109.9	0.364	47.7
400	5.3	130.4	0.353	50.8
500	4.3	163.3	0.342	56.2

Weight per cubic foot, one of the units of measurement used to compare the effect of chemical treatment on weight reduction, depends upon both the moisture content and the basic density.

It was considered that if a group of test disks representing a sample of four or five trees showed a tendency to vary in weight with increasing height in the trees, it obviously would be wrong to consider all the disks from the largest butt sections to the 4-in. tops as of equal importance. Therefore, in order to compute the average weight per cubic foot (or moisture content, etc.) of each test group, it was necessary to use some method of weighting the test disks of various diameters according to the relative volume of wood that they represented. Since in most cases the samples had been cut at 100-in. intervals, the volume factor was determined from the average diameter and from the number of pieces representing each level. The average weight per cubic foot of wood in a sample consisting, for instance, of some 25 disks from five trees was, therefore, computed by multiplying the mean weight per cubic foot at each level by the relative volume factor of the test disks at that level. The products of weight times volume for the various heights were then added and the sum divided by the total volume represented by all test pieces to give a weighted average weight per cubic foot for the sample group. A similar method of weighting was employed in computing average moisture content and average specific gravity.

Fig. 10. Pouring dry soluble chemicals between paper band and sapwood

OBSERVATIONS

Ease of Peeling

Soluble forms of arsenic proved to be the most effective chemical for facilitating removal of bark. When applied during the sap-peeling season, soluble arsenic appeared to kill the bark quickly in the easy peeling condition so that, especially in the coniferous species, it could be removed in large pieces or long strips. The bark of trees treated with arsenic appeared damp and pliable when removed, and this contributed to its easy removal. Treatment with ammonium sulphamate gave easy removal of bark in some tests, but owing to attack by bark insects, there was a tendency for the bark to break along insect tunnels and to come off in small pieces. In most cases the bark did not separate cleanly from the wood in trees treated with ammonium sulphamate, shreds of disintegrating bark being left on the surface of the peeled log.

Many other chemicals, although eventually killing the tree, did not produce easy peeling, apparently because death was slow. Some compounds appeared to affect the bark for only a short distance above the girdle.

June and July were found to be the best months for application of chemicals in order to effect easy peeling during the year of treatment. Trees treated with soluble arsenic during these months generally were easy to peel when the sap-peeling season was over but peeling became easier if such trees were allowed to stand until autumn. Trees treated with soluble arsenic in June and July and felled in late Autumn peeled easier than untreated trees felled and tested during the season of easy peeling. In many cases, arsenic-treated trees of the coniferous species could be peeled without the aid of peeling tools.

With a black spruce treated in July, 1946, with a mixture of soluble arsenic (dry weight of arsenic 15 grams) and sodium chlorate (28 grams) and felled and tested in mid-November, 1946, the bark peeled in large pieces leaving the surface of the sapwood free. Figure 11 shows the ease of peeling chemically treated white cedar. These trees had received treatment with soluble arsenic in July and were felled and peeled in November. Peeling the broad-leaved species treated with arsenic was not as easy as was the peeling of conifers since the bark was thicker and harder. However, treatment of poplar and birch generally resulted in making bark easier to peel than that of untreated trees felled and tested during the sap-peeling season. The aspen trees shown in Fig. 12 were treated in June, 1946, with a mixture of soluble arsenic and sodium chlorate. When felled and tested (mid-November) at a time when it was impossible to peel untreated trees the bark was very easy to remove from the treated trees. Treatments which gave easy peeling by October were found to continue their effects the following year. Figure 13 shows white cedar of pole size treated with soluble arsenic during the sap-peeling season and and felled in late Autumn. The photograph was taken in March after the poles had been hauled to a central location for peeling. The same logs are shown in Fig. 14 during peeling operations in March at a time when untreated trees were very

Fig. 11. Peeling chemically treated white cedar in November

difficult to peel. It can be seen that the bark has been removed in long strips leaving a bark-free sapwood surface.

Treatments applied too late (late August and September) to secure ease of peeling during the year of treatment generally gave, for most species, easy peeling a year following treatment. With the exception of poplar and birch, the bark of trees so treated could be removed easily in the Autumn a year after treatment although the bark could not be peeled in pieces as large as those from trees treated during the sap-peeling season. In aspen the bark could be removed about as easily as from untreated trees during the season of easy peeling. A partially peeled jack pine which had been treated with soluble arsenic in September, 1947, is shown in Fig. 15. The photo, taken in September, 1948, illustrates that although treatment was applied after the normal peeling season the bark was easy to remove a year following treatment.

When the chemicals were not evenly distributed around the girdle, the resulting ease of peeling was not uniform. The chemicals tended to affect the bark directly above the point of application. The bark remained alive above areas of the girdle which did not receive chemicals and was difficult to remove after the normal sap-peeling season.

With the exception of white cedar, the peeling below the level of application of chemicals was generally harder than that above the girdle. In some cases the bark below the girdle did not appear to be affected as completely, except where the chemicals had been absorbed in somewhat irregular streaks. However, the bark below the girdle in white cedar treated with arsenic appeared to be in much the same condition as that above the girdle and could be peeled almost as easily. Figure 16 illustrates the ease of peeling, both above and below the point of application of chemicals, in a white cedar tree treated with soluble arsenic during the sap-peeling season and tested in November.

The bark of trees which were girdled only was generally in the same condition as that of control trees when tested during the same period and sometimes was more difficult to remove.

Quality of Treated Material

Bark insects were sometimes observed, especially in the conifers (with the exception of white cedar) in trees treated in June and July and felled in the Autumn. Trees treated with chemicals such as ammonium sulphamate were more severely attacked than those treated with arsenic, which doubtless had some toxic effect on insects. Figure 17 shows attack by bark insects in a tree of aspen poplar treated with ammonium sulphamate in June and felled in November. As indicated previously, the attack of bark insects in trees treated with sulphamate contributed to the fact that such trees were harder to peel than those treated with arsenic, the bark breaking into small pieces. Trees which showed the most weight reduction

Fig. 12. Bark removal from treated aspen poplar in November. (Note dark coloration on surface of sapwood)

Fig. 13. Chemically treated cedar felled in November. Photo taken the following March

generally showed the most severe attack by insects, especially in top logs where the greatest drying usually occurred.

Some trees of the coniferous species, especially jack pine treated in June and July, showed considerable attack by wood borers when felled in the Autumn of the year of treatment. Trees treated in late Summer, although showing no attack by wood borers when tested a month following treatment, showed traces of attack when felled the following June, the attack becoming more severe during the warm months. Some attack by wood borers was observed in broad-leaved species when felled a year following treatment.

Traces of blue-stain were found in the sapwood of the coniferous species treated in June and July and felled in October of the same year, the attack being more severe in top logs of jack pine where considerable drying had taken place.

In most cases where easy peeling resulted from chemical treatment, the surface of the sapwood was superficially stained from tan to dark brown. This stain did not appear to be the result of a staining organism but rather of a chemical reaction. However, the stain was confined to the surface in most cases and did not penetrate into the wood. Figure 12 illustrates the stain in aspen poplar.

The sapwood of some trees allowed to stand for two summers after treatment showed signs of decay.

Changes in Weight of Peeled Wood

Reductions in weight of wood were found in trees of the coniferous species. Except in a few instances, the wood of chemically treated trees of the broad-leaved species showed no appreciable decrease in weight when felled at various times following treatment and in some cases was actually heavier than wood of untreated trees.

Changes in weight of wood are summarized by describing the effects of treatment on coniferous species and on broad-leaved species.

Coniferous Species. Appreciable reduction in weight was found in chemically treated jack pine, balsam fir, and white spruce, depending upon the times of treating and felling. Black spruce did not show weight reductions as great as those found in the other coniferous species since black spruce contains relatively narrow sapwood, the region in which most of the drying normally occurred following treatment.

Differences of reduction in weight of jack pine caused by treatment with soluble arsenic and ammonium sulphamate, the two treatments which produced the greatest drying, were not significant, one chemical generally effecting as much reduction as the other. However, in some cases, trees treated

Fig. 14. Logs shown in Fig. 13 during peeling operations in March

with ammonium sulphamate tended to show somewhat more rapid drying than those treated with arsenic. In balsam fir treatment with sulphamate appeared to produce slightly more reduction in weight than treatment with arsenic, especially when chemicals were applied during June and July.

Jack pine and black spruce, girdled but not chemically treated, showed only slight reduction in weight when sampled during the year of girdling. However, when trees were felled during the late Summer of the year following girdling, decreases in weight approaching those for trees which were treated with chemicals were recorded. Balsam fir trees which were girdled only showed somewhat greater decreases in weight during the year of girdling than did jack pine and black spruce, and when felled and sampled the year following weight reductions comparable to those of chemically treated trees were recorded.

In trees where chemical treatment was successful in reducing the weight of wood, the greatest reduction occurred in wood from the upper levels, the region which contains the largest proportion of sapwood. The wood at stump height (2 or 3 ft. below the girdle) generally increased in weight during the year of treatment in jack pine and black spruce but by the Autumn of the year following treatment the weight of wood at this level was generally about the same as or slightly less than that of material at a similar level of untreated trees. Wood at stump height of chemically treated balsam fir did not show the tendency to increase in weight after treatment.

Table III gives the weight in pounds per cubic foot of wood from various levels in untreated jack pine felled in July, 1947, and in trees treated with soluble arsenic in July, 1947, and felled October, 1947, and September, 1948.

Table III. Jack Pine

Height in tree, in.	*Weight of peeled wood, lb. per cu. ft.*		
	Untreated, felled July, 1947[a]	*Treated with arsenic in July, 1947* — *Felled October, 1947*[a]	*Felled September, 1948*[b]
Butt	47.6	55.7	43.5
100	46.4	45.1	32.6
200	48.9	40.9	31.5
300	51.0	...	32.8
400	51.0	36.1	30.8
500	55.6	35.0	30.3
600	59.2	36.5	31.8
Weighted averages (based on material from 100 ft. up)	49.3	41.0	31.8

[a] 5 trees. [b] 21 trees.

The tendency for wood from the upper levels of trees to show the most reduction in weight is illustrated in Fig. 18. The weight is shown in pounds per cubic foot of peeled wood at different levels in jack pine trees which were treated with chemicals in June and felled at various periods. The weights per cubic foot of wood at different levels in trees treated with arsenic, ammonium sulphamate, and a mixture of arsenic and sulphamate were averaged. A curve is included showing the weight per cubic foot of wood from a test group of untreated (control) trees felled and sampled in June, 1947, the month during which the sample groups presented in the graph were treated. As shown in Fig. 18, only slight drying took place during the first month after treatment but trees felled from 2 to 4 months after treatment had undergone a significant reduction in weight. Continued loss of weight in material above the girdle was evident when trees treated in June, 1947, were sampled in May and September, 1948. It may be seen from this figure that material loss in weight had occurred at the 100-in. level by May of the year following treatment and continued until September.

June and July appeared to be the best months for application of chemicals in order to accomplish reduction in weight of wood during the year of treatment, the effect of June and July treatments being similar. This is graphically illustrated in Fig. 19 which indicates the average weight per cubic foot of peeled wood (weighted according to diameters of test samples) from the 100-in. level to about a 4-in. top of jack pine trees treated from June to September, 1947, and felled at various times during 1947 and 1948. The points on the graphs are averages of treatment with soluble arsenic, ammonium sulphamate, and a mixture of arsenic and sulphamate, each point representing the weighted average of samples at 100-in. intervals from about 15 trees. A curve is included for untreated control trees (each point representing the weighted average of samples from about five trees) felled at various dates from June to October, 1947, and from May to September, 1948.

It may be seen in Fig. 19 that the average weight of wood above the girdle in jack pine treated with chemicals in June and July showed appreciable reduction when felled two months after treatment. For example, wood of trees treated with chemicals in June and felled in August averaged almost 7 lb. lighter in weight per cubic foot than wood from untreated trees felled and sampled the same month. Trees of

Fig. 15. Bark removal from jack pine treated in September and tested in September the following year. (Note hard peeling below girdle)

Fig. 16. Peeling treated white cedar in November. (Note ease of bark removal below girdle)

jack pine treated in June and July and felled in October showed weight reductions above the girdle of more than 10 lb. per cu. ft. Based on an average of 88 cu. ft. of solid wood per cord of jack pine, 10 lb. per cu. ft. reduction in weight would mean a decrease of about 900 lb. per cord.

When trees treated in June and July were felled and sampled in the Spring of the year following treatment, further decreases in weight were observed. This reduction in weight continued during the Summer of the year following treatment. When felled in September, jack pine trees treated in June and July of the previous year showed decreases of between 16 and 17 lb per cu. ft. as compared to untreated trees felled and sampled during June.

Figure 19 indicates that although some reduction in weight of wood in trees treated during August had taken place by October, the greatest reduction in weight was observed when such trees were felled a year following treatment. Trees treated in September also showed considerable reduction in weight when sampled a year following treatment.

A three-dimensional graph (Fig. 20) is included to show the weight reduction in jack pine treated with soluble arsenic in June, 1947, and felled at various dates from July to October, 1947, and in May and September, 1948. The line indicating weight per cubic foot in June, 1947, is based on material from untreated "control" trees while all other points on the graph are averages of trees treated with arsenic. By tracing individual curves from left to right the changes in weight of wood may be observed at each level in the trees for some 15 months after treatment (in June). These curves are crossed by others (shown by closely spaced vertical lines) which indicate the average weight of wood at different levels in the trees as determined each time a group was felled for sampling.

Weight reduction in balsam fir followed much the same pattern as in jack pine although decreases in weight were not as great. The wood above the girdle of trees treated in June showed reduction in weight of about 7 lb. per cu. ft. when felled in October of the same year and about 13 lb. when felled in the Autumn of the year following treatment. Trees treated late in the Summer showed appreciable weight reduction when felled and sampled after standing for a full year.

Black spruce, generally, was not appreciably lighter in weight when felled during the year of treatment. When tested during the year following treatment, the greatest reduction in weight of peeled wood was found in trees treated during June and July, with reductions in weight of about 7 lb. per cu. ft. being recorded when such trees were felled in September.

Although no detailed tests of white spruce were made in which trees were treated at monthly intervals during one Summer and felled at various times, the records available indicate weight reductions comparable to those of jack pine. The weight of small cedars was reduced in one Summer to about 15% less than that of untreated cedar.

Broad-leaved Species. In the broad-leaved species tested, aspen and balsam poplar failed to show any appreciable change in weight of wood owing to chemical treatment while wood of chemically treated white birch generally was heavier than that of untreated trees.

Figure 21 is presented to show the weights per cubic foot of

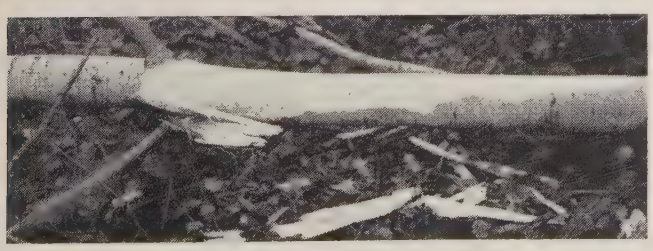

Fig. 17. Aspen poplar treated with ammonium sulphamate showing attack by insects

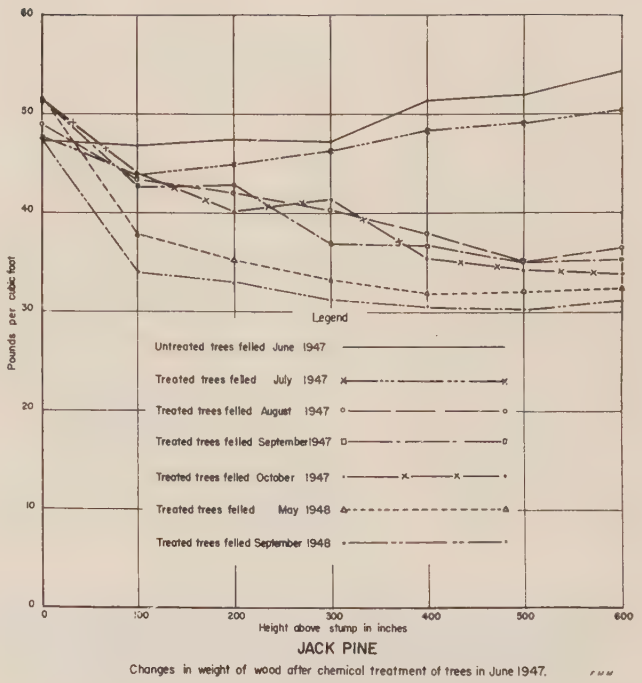

Fig. 18. Changes in weight of wood of jack pine at various levels after treatment with chemicals in June, 1947, compared to untreated trees felled in June, 1947. Curves show decrease in weight per cubic foot of wood after various periods of time following treatment

wood of aspen treated with chemicals from June to September, 1947, and felled at various times in 1947 and 1948. A curve giving the weight of wood from untreated trees felled at various times is included. Each point on the curves for treated trees represents the weighted average weight per cubic foot of wood from 15 to 20 trees weighted according to diameters of the test disks, while each point on the curve for untreated control trees represents the average for about five trees. In Fig. 21, the curve for trees treated in August is somewhat lower than the average since the wood of these trees exhibited low basic density.

It may be observed from Fig. 21 that the weight of chemically treated aspen showed no appreciable change from that of untreated trees. In some cases records show that the weight of wood in the upper levels of treated trees had a lower weight than that from the same region of untreated trees. However, this reduction was not significant.

The wood of balsam poplar treated with chemicals in June and July was slightly lighter than that of untreated trees when sampled the year following treatment owing to a small amount of drying in the upper levels.

The weight per cubic foot of wood from chemically treated white birch was greater than that of untreated trees felled during the same months. For example, white birch treated with chemicals in June and felled in October had a weighted average weight of about 60 lb. per cu. ft., as compared to wood from untreated trees which weighed 55 lb. when felled.

The wood at stump height (i.e., below the girdle) in chemically treated broad-leaved trees was generally heavier than wood from the same region of untreated trees.

In general, no significant reduction in weight was found in trees of the broad-leaved species girdled only, the weight per cubic foot being approximately the same as that for wood of ungirdled control trees.

Effect on Buoyancy of Logs

Application of chemicals to trees appeared to have a beneficial effect on the buoyancy of jack pine and balsam fir only, the two species which showed appreciable drying. Other species tested—black spruce, aspen, balsam poplar,

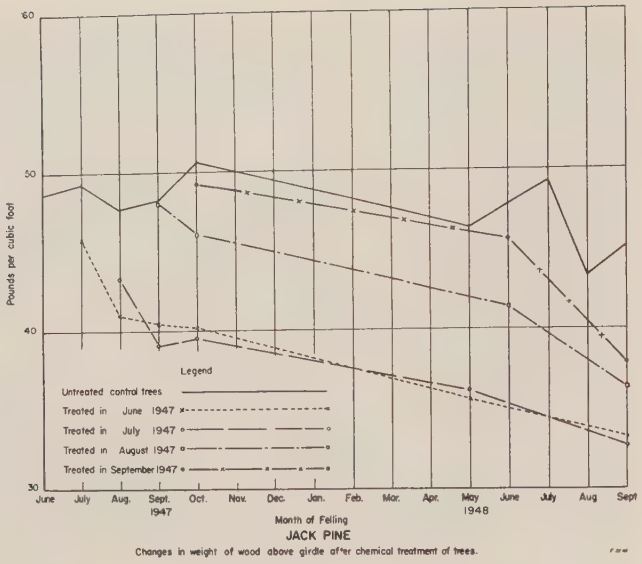

Fig. 19. Curves showing changes in weight of wood (above girdle) in jack pine after various treating periods. Points on the curves indicate the weighted average weight per cubic foot of wood from trees which had been standing for different periods of time following treatment

and white birch—did not show significant improvement in buoyancy following chemical treatment, and so are not included in this description of results. It should be noted that the results of the limited flotation tests herein reported do not represent the average for the species, but indicate only the floatability of logs tested.

Table IV gives the margin of flotation (percentage of log volume above water) of jack pine logs of different diameter classes from a group of untreated trees felled and floated in July, 1948.

Table IV. Jack Pine—Logs with Bark

Untreated: felled and floated July, 1948

Diameter class, in.	*Initial floating margin, %*	*Floating margin, %, after 5 days*	*17 days*	*44 days*	*79 days*
4	5	0	0	0	0
5	10	4	4	2	0
6	16	11	8	6	5
7	13	9	7	8	7
8	22	18	15	11	8
9	26	25	23	22	18

It will be seen from this table that top logs of untreated jack pine sank a few days after watering while logs of larger diameter showed a higher initial floating margin and remained afloat after 79 days in the water. The relatively large proportion of wet sapwood is responsible for the low initial floating margin of logs of small diameter.

Where chemical treatment of jack pine trees was successful in reducing the weight of wood, small top logs showed the greatest reduction in moisture content so that their initial floating margin was greatly improved. Table V indicates the floating margin of logs of various diameter classes from jack pine trees which were felled and floated one year following treatment.

This table shows that the initial floating margin of logs of all diameter classes was improved, the greatest improvement being in top logs. After three weeks in the water, however, the floating margin of small seasoned logs was less than that of seasoned logs of large diameter. When last measured (almost 3 months after floating) all logs from the group of seasoned trees were floating and in general showed a higher floating margin than did logs of green trees remaining afloat for approximately the same length of time.

Logs of chemically treated balsam fir which were appreciably reduced in weight had much higher initial floating margins than logs from untreated trees. However, the high margins of flotation gradually decreased so that at the time of the last measurement (78 days after floating) the buoyancy of logs from treated trees was generally similar to that of logs from untreated control trees that had been floating for the same period.

Table V. Jack Pine—Logs with Bark

Treated July, 1947; felled and floated July, 1948

Diameter class, in.	*Initial floating margin, %*	*Floating margin, %, after[a] 9 days*	*21 days*	*48 days*	*83 days*
5	37	17	7	7	7
6	43	19	12	12	11
7	45	26	22	26[a]	24
8	33	27	21	22[a]	21
9	32	19	19	23[a]	17

[a] Slight temporary increases in buoyancy have been observed occasionally during warm weather in other flotation tests.

RESULTS AND DISCUSSION

Results of tests in chemical treatment of trees indicate that peeling easier than sap-peeling can be obtained by applications of soluble arsenic to trees during June and July. The easy peeling of trees so treated was observed until November of the year of treatment and continued during the year following treatment. In coniferous species, especially jack pine, such trees could be peeled in many cases without the aid of peeling tools. Treated trees of the broad-leaved species were harder to peel than the conifers because of the thick and hard nature of the bark. However, even with poplar and birch it was found that the bark could be removed easier from treated trees in the late Fall than from untreated trees during the sap-peeling season.

Treatment with soluble arsenic in August and September generally did not produce easy peeling until the following year when bark removal became progressively easier from July to September.

Appreciable reduction in weight was observed in trees of jack pine, white spruce, and balsam fir. The loss of weight of black spruce was not as great. Trees of the broad-leaved species showed no significant reduction in moisture content and the wood of white birch actually increased in weight. Although, in some cases, ammonium sulphamate appeared to effect slightly more reduction in weight than soluble arsenic, the difference was not significant.

Wood (free from bark) of jack pine and balsam fir from trees treated during June and July was appreciably lighter in weight than wood of untreated trees when felled in October of the year of treatment. Late treatments (made in August) were not as effective in reducing weight of wood while trees treated in September and sampled 1 month later generally showed no reduction in weight.

Trees of jack pine and balsam fir treated from June to September continued to lose weight throughout the year following treatment. Trees of jack pine treated in June and July showed an average loss in weight of wood above the girdle of about 17 lb. per cu. ft. when felled in September of the following year (some 14 months after treatment) while those treated in August and felled during the same period showed a reduction of about 12 lb. per cu. ft.

With regard to the quality of the treated material, trees of the coniferous species (with the exception of cedar) in which treatment was most effective in reducing weight generally showed the most attack by bark insects, wood-borers, and blue-stain of the sapwood. Trees treated with ammonium

sulphamate were more severely attacked by bark insects than trees treated with arsenic which evidently had some toxic effect on insects. In trees treated with sulphamate, the attack was sufficient to cause the bark to break along the insect tunnels so as to permit peeling only in small pieces.

From the foregoing it may be concluded that, of the chemicals tested by the Laboratory, application of soluble forms of arsenic provides the best treatment to obtain easy peeling and to keep attack by insects at a minimum. Coupled with this and in most instances, weight reductions effected by applying soluble arsenic were as great as those in which other chemicals were employed.

Action of Tree-Killing Chemicals

The killing action of properly applied toxic chemicals can first be noted on the foliage, usually within a week following treatment. The leader in the conifers or the upper crown in the broad-leaved species generally shows discoloration and shriveling of the foliage. Of course, the killing effects are at first more apparent in the leaves of the broad-leaved species since it is difficult to distinguish any initial wilting in the leaves of the conifers. An observation of interest was the fact that leaves of trees of the broad-leaved species treated with soluble arsenic tended to shrivel, turn brown, and remain on the tree while those of trees treated with ammonium sulphamate shriveled and fell to the ground. This may indicate that ammonium sulphamate reacts somewhat slowly in causing death to the tree allowing a layer of abscission tissue to form at the base of the leaf petiole, whereas with a more toxic chemical such as soluble arsenic the killing effect is too rapid to allow this tissue to form.

Quick killing by soluble arsenic may explain the fact that in some tests the application of soluble arsenic close to the end of the sap-peeling season (as late as the first week in August) gave easy peeling in the Autumn while no other chemical applied at the same time produced the same effect.

As already indicated, application of chemicals to the exposed sapwood of species which normally contain resin ducts must be made immediately after girdling. If application of chemicals is delayed the formation of a film of oleo-resin may impede the absorption of chemicals into the sapwood. In tests where the alkaline arsenic paste was used, there was little evidence of resin accumulations at the girdle when trees were observed after treatment. With sulphamate, however, deposits of hardened resin were generally found in the girdle after the tree had been standing for some time following treatment. This also may be a factor in explaining the effectiveness of soluble arsenic.

In trees which were felled and observed following a period

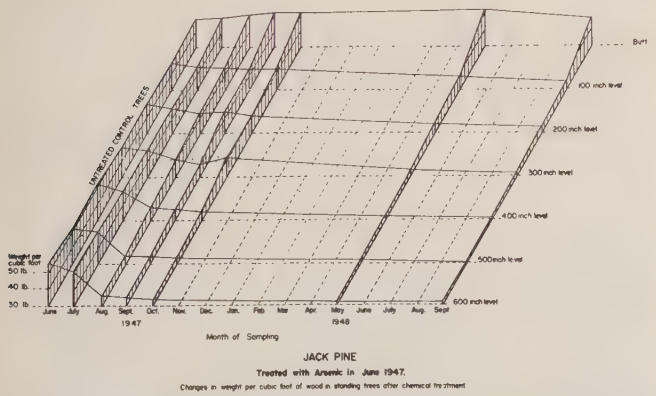

Fig. 20. Three-dimensional graph showing changes in weight per cubic foot of wood at different levels in jack pine treated with soluble arsenic in June, 1947. Reduction in weight when felled at intervals after treatment is also shown and compared with weight of wood from untreated trees

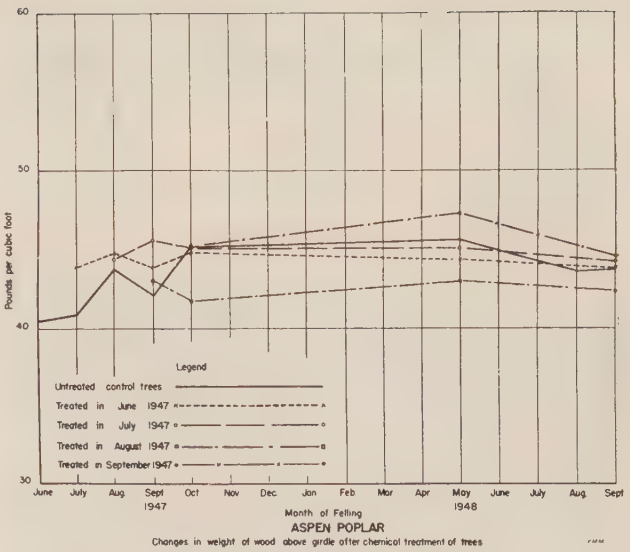

Fig. 21. Curves showing changes in weight of wood (above girdle) in aspen poplar after various treating periods. Points on the curves indicate the weighted average weight per cubic foot of wood from trees which had been standing for different periods of time following treatment

of standing after treatment, the sapwood surface of the peeled logs was not resinous. Woods labor found the peeled logs from such treated trees relatively clean to handle as compared with the somewhat sticky surface of newly sap-peeled spruce and pine.

Effect on Surrounding Trees

A few instances were observed where chemicals had passed from a treated tree to a nearby untreated tree apparently through an underground connection. In experiments at the Petawawa Forest Experiment Station an occasional ungirdled and untreated aspen poplar tree a few feet from another aspen which had been treated with soluble arsenic paste was observed to possess foliage in the same condition as the treated tree (i.e., leaves dead but remaining on the tree). When these untreated trees were felled and tested, the ease of bark removal was similar to that of the treated tree. Instances of chemicals (arsenic) killing neighboring trees were also found in white cedar treated at Petawawa. In one experiment, a cedar standing in a group of about eight cedars was treated with soluble arsenic during the early Summer. Progressive killing of other trees (untreated) in the group was observed at monthly intervals until Autumn when more than half of the trees in the group showed effects of the toxic chemical on their foliage, some trees having completely dead foliage and exhibiting peeling characteristics similar to those of the treated tree.

In areas where the tests were conducted, the growth of tree seedlings was not adversely affected by application of chemicals to large trees. In fact, in many instances, excellent regeneration was observed in stands which had been treated two or three years previously. Seedlings which had been small at the time of treating subsequently showed rapid growth since the previously dense canopy had been opened owing to defoliation of the treated trees.

Costs of Treatment

Time records were kept in the large-scale experiment at Stevens to indicate the time consumed in girdling and applying chemicals. A team of two men with hand tools, girdled the trees while two men working together applied the chemicals on a band of crinkled kraft paper to the girdled trees. Table VI indicates the number of trees girdled with the V-tool previously described and the number girdled and treated per man-hour in experimental treatments.

Table VI. Trees Girdled and Treated per Man-Hour

Species	—Number of trees (pulpwood size) per man-hour— Girdled—no chemical applied	Girdled and treated with chemicals
Jack pine	29.3	10.5
Balsam fir	22.3	10.3
Black spruce	32.0	11.3
Aspen poplar	25.7	9.4
Balsam poplar	22.3	8.4
White birch	26.5	10.1

It must be borne in mind that the figures in Table VI are for crews of inexperienced men working with hand tools. Had it been feasible to keep an experienced crew throughout the treating period, the number of trees treated per man-hour might have been significantly increased. Factors that affect the rate of treatment are the same as those affecting efficiency in felling, such as experience of operators, the nature of the stands, and local conditions.

Treatments from which the figures in Table VI originated involved application of different chemicals, and this undoubtedly was more time-consuming than if only one chemical had been consistently applied. Chemicals were applied by pouring the prepared paste on a paper band, wrapping the bandage around the girdled tree, and fastening it with a tack. As shown by recent tests, application of chemicals to trees can be accomplished by brushing a paste of a highly toxic chemical on the girdle without the covering band of paper. This would substantially decrease the amount of labor required in that only one man would be needed to apply chemicals with a brush and no time would be spent in cutting and fastening the paper. The cost of paper and tacks would also be saved.

Applications of soluble arsenic paste containing as little as a half-ounce (air-dry) of white arsenic made peeling easy in trees of 6 to 10 in. diameter. In subsequent tests, easy peeling was obtained after brushed application of arsenic as a relatively thin paste. Thus the effectiveness of much smaller quantities is demonstrated, provided that such toxic chemicals can be efficiently applied.

The gasoline-powered portable girdling tool, recently developed, has been reported to be satisfactory; this should considerably accelerate treating operations. Methods of increased efficiency in the application of chemicals to trees will no doubt evolve if the process becomes widely used on a large scale. It may also be anticipated that new chemicals producing as easy peeling as arsenic, more effective as inhibitors of insects and staining fungi, and which can be more easily and safely applied will be found.

Dangers in Using Arsenic Paste

Although garden and field sprays containing arsenic are safely handled and applied by many, a word of caution in the preparation and use of the arsenic paste is in order. Painful rashes develop when arsenic and sodium hydroxide come in contact with the skin, or when arsenic dust or sodium hydroxide fumes are inhaled or are in contact with the skin during the preparation of the paste. Extreme care should be maintained while the paste is being prepared.

It is suggested that the paste should be prepared by technicians accustomed to handling such materials. In applying arsenic paste, rubber gloves were worn as a protection against accidental contact with the skin. If contact takes place, the area should be thoroughly washed immediately. The effects of arsenic taken internally are so serious that all necessary protective measures should be strictly enforced.

It has been found that the flour used in the paste attracts both farm stock and wild life; addition of phenol or a similar repellant provides a safeguard.

CONCLUSIONS

1. The bark of trees of the species under test, when appropriately treated with chemicals, could be removed more easily after the season of easy peeling than could that of untreated trees felled and peeled during the sap-peeling season.

2. Of all treatments tested, uniform application of soluble arsenic proved to be the best for facilitating removal of bark.

3. June and July and possibly the first part of August were found to be the best months for application of chemicals in order to render the bark easy to peel in the Autumn of the year of treatment.

4. Trees treated after the normal peeling season generally showed easy peeling only after a year following treatment.

5. Significant reductions in weight occurred in trees of jack pine, balsam fir, and white spruce which were treated in June and July and felled during the Autumn of the year of treatment. Further reductions in weight were apparent when trees so treated were felled during the year following treatment. Black spruce did not show a decrease in weight as great as that of the other coniferous species.

6. Application of chemicals to conifers in August and September generally did not reduce the weight of wood significantly until the year following treatment.

7. The wood of chemically treated aspen and balsam poplar showed no appreciable reduction in weight while the wood of treated white birch was usually heavier than that of untreated trees.

8. Soluble arsenic and ammonium sulphamate appeared to be the best chemicals for reducing the weight of wood of species susceptible to decrease in weight.

9. Traces of bark insects and wood borers were found in trees which had been reduced in weight. Less attack by insects was found in trees treated with arsenic than in those treated with sulphamate. In no case was insect and blue-stain attack sufficiently severe to cause significant de-grade.

10. As expected, the buoyancy of logs from species showing significant reduction in weight following chemical treatment (jack pine and balsam fir) was in general substantially improved.

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Electric Wire and Cable Recommendations for the Pulp and Paper Industry*

Tappi Engineering Division Project No. 369

A. O. MORTENSON

THIS report summarizes the recommendations of the subcommittee on the selection of wire and cable for the industry. The committee comprised authorities in the field of wire and cable, representatives of the Insulated Paper Cable Engineers Association (abbreviated as IPCEA), cable manufacturers, and operators of both American and Canadian mills. The committee made an exhaustive survey of the paper industry in 1951 and 1952 to learn of cable service experience, operating conditions and requirements, installation methods, etc., for guidance. Then several meetings were held in which the problems, exposures, etc., and requirements peculiar to the paper industry were carefully reviewed and fully discussed. The committee recognized the fact that installation practices vary and, therefore, the recommendations include four of the most common methods of installations.

Wire and cable recommendations covering practically every department and service in the industry are included. Adoption of these recommendations by TAPPI is urged. Such action will do much toward assuring the pulp and paper mills maximum service from their wire and cable installations and assist in unburdening the electrical engineers of the industry faced with all the decisions involved in a wiring program of any consequence, be it construction of a new plant or extension or renovation of an existing one.

These recommendations apply generally to both American and Canadian mills; one exception, pertaining to paper-insulated cables peculiar to some Canadian mills, is discussed separately.

BASIS OF RECOMMENDATIONS

The selection of cable should be based on: (1) the proper insulation, (2) type or method of installation, (3) over-all reliability of the power-distribution system, and (4) cost.

Continuity of power so vital in the paper industry may be only as reliable as the weakest link; experience and service records have shown that the weakest parts have been the cable terminations, such as potheads. Because of this dual cable circuits were often required thus increasing the cost of the entire power system and adding to operating complications.

The present trend for improved reliability is toward cables not requiring potheads such as synthetic rubbers and varnished-cambric interlocked-armored cables. With the elimination of potheads the trend is toward the simple radial-type distribution system which costs less and is much simpler to operate. Thus, the cable selection is an important factor in the over-all cost of the distribution system; what may be the lowest cost cable may not result in the lowest cost power system.

The attached application tables show the recommended cable selection in terms of areas, exposure, voltage classes, and installation methods. All of these cable types have been proved in paper mill service and are commercially available from manufacturers.

The number of alternative selections was purposely limited in keeping with a practical approach. Also, it should be noted that the types of cable for an entire mill reduce to only a few; this is true because many cable insulations are applicable for a variety of exposures; e.g., wet, and various chemicals, liquors, etc.

Even though these tables do not include every area for every type of paper mill it is believed that by comparing the actual exposure conditions with those in the tables the proper cable can be selected.

The use of these tables and data must be tempered with practical realities; e.g., even though a specific area may be "dry," yet if the cable runs through, say a liquor, chemical, or wet area, the cable should be selected for the most adverse conditions.

USE OF IPCEA CABLE SPECIFICATION

The adoption of cable specifications as a TAPPI Standard was considered but dropped because it would be impractical for TAPPI to maintain such specifications up to date. The committee recommends that the industry follow the specifications set forth in the IPCEA Specifications.

Industry as a rule does not buy cable on individual specification; generally all that is necessary is to state that the cable "... be in accordance with the latest applicable IPCEA Specifications."

DIFFERENCES IN AMERICAN AND CANADIAN PRACTICES IN USE OF PAPER-INSULATED CABLES

It will be noted in the application tables that paper-insulated cable is not included.

TAPPI CABLE RECOMMENDATIONS

Table I. Cable Description

Cable type	*Description*[a]
1	Heat and moisture resistant rubber insulation with neoprene sheath
2	Polyvinylchloride insulation
3	Varnished cambric insulation, polyvinylchloride jacket with interlocked armor[b]
4	Varnished cambric insulation with lead sheath with neoprene or PVC hose jacket[c]
5	Ozone resistant rubber[d]
6	Asbestos varnished cambric with lead sheath and hose jacket (for dry locations lead sheath and hose jacket may be replaced by an asbestos braid)
7	Mineral insulation
8	Manufacturers' recommendations

[a] All cables to be manufactured in accordance with latest applicable Insulated Power Cable Engineers Association (IPCEA) specifications.

[b] The armor may be made of galvanized steel, bronze, or aluminum to be used as follows: Galvanized steel—dry locations only, no chemical fumes. Bronze—exposure to atmospheres containing liquors, chlorine, alkali. Aluminum—exposure to sulphur compounds, moisture.

[c] Wherever varnished cambric lead is listed, paper-insulated lead-covered cable with proper hose jacket can also be used if competent cable splicers are available.

[d] For applications above 3000 v. shielding is required; below 3000 v. shielding is optional.

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* This report will be discussed at the 8th Engineering Conference of the Technical Association of the Pulp and Paper Industry, which will be held at the Sheraton-Mt. Royal Hotel, Montreal, Que., Oct. 26-29, 1953.

Although paper is an excellent cable insulation it has little mechanical strength, is susceptible to moisture absorption, and requires extreme care in making proper terminations and splices. It is this termination problem—i.e., the lack of trained personnel to make joints properly—that has led American industry to avoid paper cable. This is in contrast to some Canadian mills who have the trained personnel and who have had good experience with paper-insulated cable.

However, if properly installed, paper-insulated-leaded cable can be used in the same areas, exposure conditions, and installation methods listed for varnish-cambric-leaded cable.

The committee recommends that leaded cables have a hose jacket over the lead to prevent electrolysis, or chemicals from damaging the lead.

D.C. APPLICATIONS

The committee suggests that the same types of cables be used for d.c. applications as listed for a.c.; the evidence available regarding operating experience for d.c. service did not indicate that any special cables were necessary.

SELECTION OF CABLE FOR GROUNDED-NEUTRAL AND UNGROUNDED-NEUTRAL SERVICE

Cables for service voltages above 5 kv. are available for either "grounded-neutral service" or "ungrounded-neutral service"; i.e., applicable to grounded neutral or ungrounded power-distribution systems.

Most paper mills with voltages above 5 kv. have a

Table II. Installation Conditions and Cable Recommendations[a]

			—Cable type recommendation; method of installation—		
Area	*Exposure*	*Voltage*	*Conduit or underground duct*	*Aerial cable*	*Open, racks, trays, troughs, etc.*
Acid making plant	Moisture, acid	Below 600	2(1,4)	2(1,3)	3(2,1)
		Above 600	5(4)	5(3)	3(5)
Bleach plant	Chlorine, sulphur, steam	Below 600	1(4,6)	1(3)	3(1,6,7)
		Above 600	5(4)	5(3)	3(5)
Boiler room	Dry, heat	Below 600	1(4,6)	1(3)	3(1,6,7)
		Above 600	5(4)	5(3)	3(5)
Causticizing	Lime, liquors, steam	Below 600	1(4,6)	1(3)	3(1,6,7)
		Above 600	5(4)	5(3)	3(5)
Chip preparation	Wet	Below 600	1(2,4)	1(2,3)	3(1,2)
		Above 600	5(4)	5(3)	3(5)
Chlorine plant	Chlorine	Below 600	2(1,4)	2(1,3)	3(1,2)
		Above 600	5(4)	5(3)	3(5)
Coating	Dry	Below 600	1(2,4)	1(2,3)	3(1,2)
		Above 600	5(4)	5(3)	3(5)
Control room	Dry	Below 600	1(2,4)	1(2,3)	3(1,2)
		Above 600	5(4)	5(3)	3(5)
Digester	Steam, liquors, turpentine	Below 600	1(4,6)	1(3)	3(1,6,7)
		Above 600	5(4)	5(3)	3(5)
Evaporator (liquor)	Steam, liquors	Below 600	1(4,6)	1(3)	3(1,6,7)
		Above 600	5(4)	5(3)	3(5)
Filter room (fresh water)	Wet	Below 600	1(2,4)	1(2,3)	3(1,2)
		Above 600	5(4)	5(3)	3(5)
Finishing—converting	Dry	Below 600	1(2,4)	1(2,3)	3(1,2)
		Above 600	5(4)	5(3)	3(5)
Grinder room	Wet	Below 600	1(2,4)	1(2,3)	3(1,2)
		Above 600	5(4)	5(3)	3(5)
Hemp cooking and washing	Wet, liquors, steam	Below 600	1(4,6)	1(3)	3(1,6,7)
		Above 600	5(4)	5(3)	3(5)
Lime recovery and evaporators	Wet, caustic	Below 600	2(1,4)	2(1,3)	3(1,2)
		Above 600	5(4)	5(3)	3(5)
Machine room (paper)	Wet, steam	Below 600	1(4,6)	1(3)	3(1,6,7)
		Above 600	5(4)	5(3)	3(5)
Machine shop	Cutting fluids, oils	Below 600	2(1,4)	2(1,3)	3(1,2)
		Above 600	5(4)	5(3)	3(5)
Office buildings	Dry	Below 600	1(2,4)	1(2,3)	3(1,2)
		Above 600	5(4)	5(3)	3(5)
Pulp decker, screen, and washer	Wet, liquors, steam	Below 600	1(4,6)	1(3)	3(1,6,7)
		Above 600	5(4)	5(3)	3(5)
Rag bleaching	Chlorine, steam	Below 600	1(4,6)	1(3)	3(1,6,7)
		Above 600	5(4)	5(3)	3(5)
Rag cooking and washing	Wet, steam, liquors	Below 600	1(4,6)	1(3)	3(1,6,7)
		Above 600	5(4)	5(3)	3(5)
Rag preparation	Dry	Below 600	1(2,4)	1(2,3)	3(1,2)
		Above 600	5(4)	5(3)	3(5)
Recovery boiler	Heat, liquors	Below 600	1(4,6)	1(3)	3(1,6,7)
		Above 600	5(4)	5(3)	3(5)
Stock preparation	Wet	Below 600	1(2,4)	1(2,3)	3(1,2)
		Above 600	5(4)	5(3)	3(5)
Sulphur burner	Dry	Below 600	1(2,4)	1(2,3)	3(1,2)
		Above 600	5(4)	5(3)	3(5)
Turbine room	Dry	Below 600	1(2,4)	1(2,3)	1(2,3)
		Above 600	5(4)	5(3)	3(5)
Wastepaper cooking	Wet, steam	Below 600	1(4,6)	1(3)	3(1,6,7)
		Above 600	5(4)	5(3)	3(5)
Wastepaper cutting and storage	Dry	Below 600	1(2,4)	1(2,3)	3(1,2)
		Above 600	5(4)	5(3)	3(5)
Wet machine room (thickeners)	Wet	Below 600	1(2,4)	1(2,3)	3(1,2)
		Above 600	5(4)	5(3)	3(5)
Wood room	Wet	Below 600	1(2,4)	1(2,3)	3(1,2)
		Above 600	5(4)	5(3)	3(5)
Wood yard	Outdoor, wet	Below 600	1(2,4)	1(2,3)	3(1,2)
		Above 600	5(4)	5(3)	3(5)

[a] Type numbers in parentheses are alternate recommendations.

Table III. Application Conditions

Index Key: A—dry; B—wet; C—acid, caustic, liquors; D—high temperature; E—steam

Area	*Exposure*	*Index No.*
Acid making plant	Moisture, acid	BC
Bleach plant	Chlorine, sulphur, steam	CE
Boiler room	Dry, heat	AD
Causticizing	Lime, liquors, steam	CE
Chip preparation	Outdoor—wet	B
	Indoor—dry or wet	B
Chlorine plant	Chlorine	C
Coating	Dry	A
Control room	Dry	A
Digester	Steam, liquors, turpentine	CE
Evaporator (liquor)	Steam, liquors	CE
Filter room (fresh water)	Wet	B
Finishing—converting	Dry	A
Grinder room	Wet	B
Hemp cooking and washing	Wet, liquors, steam	BCE
Lime recovery and evaporators	Wet, caustic	BC
Machine room (paper)	Wet, steam	BE
Machine shop	Cutting fluids, oils	C
Office buildings	Dry	A
Pulp decker, screen, and washer	Wet, liquors, steam	BCE
Rag bleaching	Chlorine, steam	CE
Rag cooking and washing	Wet, steam, liquors	BCE
Rag preparation	Dry	A
Recovery boiler	Heat, liquors	CD
Stock preparation	Wet	B
Sulphur burner	Dry	A
Turbine room	Dry	A
Wastepaper cooking	Wet, steam	BE
Wastepaper cutting and storage	Dry	A
Wet machine room (thickeners)	Wet	B
Wood room	Wet	B
Wood yard	Outdoor, wet	B

grounded-neutral system and therefore can use the cable for grounded-neutral service. Such cable costs less (at 13.8 kv. the savings are in the order of 20 to 40%) and is smaller in diameter thus requiring smaller conduits with an additional installation saving.

The IPCEA definition of a grounded system for cable application is "A circuit is considered to have a grounded *neutral* if the neutral is permanently connected to earth and if facilities are provided to insure prompt isolation of a faulty element of the circuit."

ALUMINUM CONDUCTORS

These cable recommendations are based on copper as the conductor element. Aluminum could be used; it is lighter in weight, but larger in diameter for the same current capacity.

Table IV. Cable Type Recommendations[a]

Application index No.	*Voltage*	*Method of installation—Conduit or underground duct*	*Aerial cable*	*Open, racks, trays, troughs*
A	Below 600	1(2,4)	1(2,3)	3(1,2)
	Above 600	5(4)	5(3)	3(5)
AD	Below 600	1(6,4)	1(3)	3(1,6,7)
	Above 600	5(4)	5(3)	3(5)
B	Below 600	1(2,4)	1(2,3)	3(1,2)
	Above 600	5(4)	5(3)	3(5)
BC	Below 600	2(1,4)	2(1,3)	3(2,1)
	Above 600	5(4)	5(3)	3(5)
BCE	Below 600	1(4,6)	1(3)	3(1,6,7)
	Above 600	5(4)	5(3)	3(5)
BE	Below 600	1(4,6)	1(3)	3(1,6,7)
	Above 600	5(4)	5(3)	3(5)
C	Below 600	2(1,4)	2(1,3)	3(2,1)
	Above 600	5(4)	5(3)	3(5)
CD	Below 600	1(4,6)	1(3)	3(1,6,7)
	Above 600	5(4)	5(3)	3(5)
CE	Below 600	1(4,6)	1(3)	3(1,6,7)
	Above 600	5(4)	5(3)	3(5)
DE	Below 600	1(4, 6)	1(3)	3(1,6,7)
	Above 600	5(4)	5(3)	3(5)

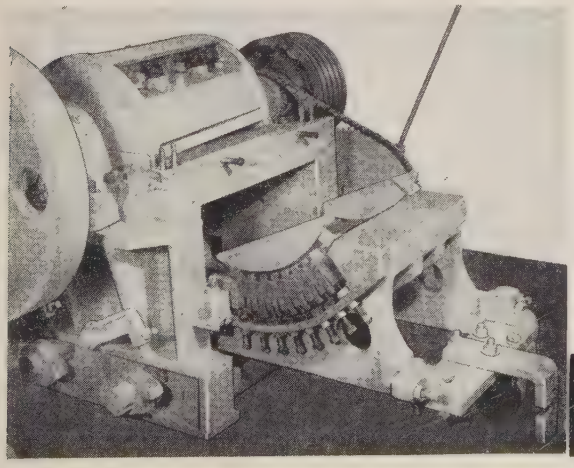
[a] Type numbers in parentheses are alternate recommendations.

The committee makes no recommendations regarding aluminum conductors because of the apparent lack of knowledge in the industry regarding acceptable and proved terminations.

INDUSTRY TRENDS AND PRACTICES

There are several pronounced trends which should be of interest to the industry:

1. Open Cable Installations. Use of open wiring methods with trays, racks, baskets, etc., in the interest of lower cost, convenience in changing, adding, or repairing cable circuits, taps, etc.
2. Installations above ground. Due to the difficulty of keeping conduits and ducts free of water, chemicals, and liquors cables are being installed above ground; generally, the installed cost is less also.
3. Use of braided cable is decreasing. The use of braid is being discouraged because it rots and disintegrates.
4. Rubber-insulated cables. These cables have excellent insulation and chemical resisting qualities; potheads, a source of trouble, are not necessary except for outdoor terminations.
5. Interlocked-armored cables. The armor offers mechanical protection so conduit is not required; the installed cost is low (up to 30% less than a conduit installation) and, except for outdoor locations, potheads are not required for terminations.
6. Aerial cable. Used especially for long outdoor runs such as filter plant, pump house, etc.



Taylor-Stiles Cutters
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Advantageous savings in power cost are being made by plants equipped with Taylor-Stiles multiplex cutters. These cutters are being used to reduce rags, cotton batting, waste paper, straw, and other materials before they are sent to the beater. Beater power consumption is only a fraction of that required when ALL the reduction takes place in the beater. This plan has proved its efficiency in power savings, lower maintenance cost, and improved product quality.

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UNITED STATES PATENTS ON PAPERMAKING

First Quarter, 1953 — *Compiled by The Institute of Paper Chemistry*

The following list of United States patents has been compiled from the current numbers of the Official Gazette of the United States Patent Office. Because, as a rule, only one claim is published in the Gazette, it is not claimed that the list is complete; also, it is possible that the list may contain some patents that do not apply specifically to pulp and paper manufacture. Copies of any of the following patents may be obtained from the United States Patent Office, Washington 25, D. C., by sending twenty-five cents for each patent desired.

January 6, 1953

2,624,079. Manufacture of air-laid felt. Thure C. Duvall, assignor to Wood Conversion Co. Filed Aug. 17, 1949. 10 claims. (Cl. 19-155.) Fibers (wood) are deposited on movable endless conveyor with deposition chambers so aligned over conveyor to give homogeneous distribution of the fibers.

2,624,245. Modified paper and method for its manufacture. Sanford L. Cluett, assignor to Cluett, Peabody & Co., Inc. Filed Dec. 16, 1947. 13 claims. (Cl. 92-68). Process and apparatus for producing uncreped paper web having permanent extensibility.

2,624,246. Method of making paper bags. William H. Bryce, assignor to Dixie Wax Paper Co. Filed Aug. 3, 1949. 2 claims. (Cl. 93-35.) A moisture-vapor resistant glassine bag with a transparent inspection window for packaging potato chips.

2,624,247. Light sensitive control for setting-up machines. Clarence L. Claff and Carl A. Moeller, assignors to Norfolk Paper Co., Inc. Filed June 18, 1947. 5 claims. (Cl. 93-36.3.) The pressure members are activated by a photoelectric cell.

2,624,248. Folding box machine. Thomas R. Baker and Edward J. Pagendarm, assignors to Bemiss-Jason Machine Co. Filed Dec. 28, 1948. 4 claims. (Cl. 93-51.) Machine can easily be changed to accommodate various box sizes by exchange of factory-adjusted gates and dies and without the complete machine readjustment.

2,624,249. Blank feeding mechanism for folding box machines. Thomas R. Baker and Edward J. Pagendarm, assignors to Bemiss-Jason Machine Co. Filed Dec. 28, 1948. 4 claims. (Cl. 93-51). Improved mechanism which feeds and deposits single blanks in correct position in a folding box machine.

2,624,309. Pasting mechanism for bag closing and sealing machines. Harold V. Kindseth, assignor to Bemis Bros. Bag Co. Filed Nov. 13, 1950. 12 claims. (Cl. 118-8.) A stream of liquid adhesive is impinged upon a wall surface area of a bag to be sealed without otherwise disturbing the bag wall.

2,624,501. Container having wax product coating. Seymour W. Ferris, assignor to Sun Oil Co. Filed Nov. 25, 1950. 9 claims. (Cl. 229-3.1.) A hydrocarbon paraffin wax with high tensile strength, flexibility, and adherence to paper, especially suitable for coating fibrous sheets and containers for packaging.

2,624,521. Dispensing package. Frank L. Broeren, assignor to Marathon Corp. Filed Jan. 7, 1952. 7 claims. (Cl. 242-55.5.) A web-dispensing package made from a single blank, comprising a container for retaining a roll of sheet material.

2,624,577. Paper jogging machine. William R. Peugnet. Filed Sept. 7, 1950. 4 claims. (Cl. 271-89.) A lightweight paper jogger that holds a stack of paper and automatically ejects paper dust and cuttings from the cradle as it operates.

2,624,655. Stable aqueous hydrogen peroxide and method of preparing same. Frank P. Greenspan, assignor to Buffalo Electro-Chemical Co., Inc. Filed Oct. 13, 1949. 12 claims. (Cl. 23-207.5.) Method consists of adding to the peroxide 5 to 1000 p.p.m. of solution of a pyridine carboxylic acid, an alkyl substituted pyridine carboxylic acid, dipicolinic acid, quinolinic acid, or 6-methylpicolinic acid.

2,624,681. Envelope seam gum and a method of preparing it. Julius Rapp, assignor to Stein, Hall & Co., Inc. Filed Sept. 21, 1949. 12 claims. (Cl. 106-210.) Adhesive of varying proportions of modified starch, urea, nonreducing sugar, and a buffering system of monosodium phosphate and disodium phosphate.

2,624,682. Felt base floor covering and method of making the same. James E. Hazeltine, Jr., assignor to Armstrong Cork Co. Filed Jan. 24, 1951. 6 claims. (Cl. 117-15.) Improved felt base floor covering with a vinyl resin coated, decorative wearing surface.

2,624,683. Flexible floor covering. Irving I. Bezman, assignor to Armstrong Cork Co. Filed Jan. 24, 1951. 5 claims. (Cl. 117-76.) Hard surface floor covering with a felt backing and a top coat of rubberlike butadiene polymer and vinyl resin.

2,624,686. High wet-strength paper and process of making. Jonas Kamlet, assignor to Mathieson Chemical Corp. Filed Nov. 4, 1948. 7 claims. (Cl. 117-155.) Process for treating paper to give it high resistance to grease, oil, soap, and other liquids.

January 13, 1953

2,624,956. Apparatus for operating molded fiber drying dies. Merle P. Chaplin. Filed Nov. 8, 1946. 6 claims. (Cl. 34-146.) Machine utilizes cam track for keeping drying dies in compressive contact with the pulp article.

2,624,989. Method of packaging elongated articles. Ray T. White, assignor to The Hankins Container Co. Filed Aug. 3, 1949. 2 claims. (Cl. 53-3.) Method of cutting and folding a protective wrapper for fluorescent lamp tubes.

2,624,995. Bag closing machine. Howard G. Allen, assignor to Savannah Sugar Refining Corp. Filed June 11, 1948. 5 claims. (Cl. 53-142.) A fully automatic machine that does the preliminary tucking and closing of filled paper bags.

2,625,084. Apparatus for setting up folding cartons and the like. Arthur J. Weiss, assignor to Robert Gair Co., Inc. Filed March 2, 1949. 4 claims. (Cl. 93-53.) Apparatus for use in setting up "simplex" type cartons.

2,625,085. Apparatus for assembling composite containers. Frank D. Bergstein. Filed Feb. 9, 1949. 7 claims. (Cl. 93-55.) Parts are accurately aligned by locating means on a conveyor on apparatus for assembling knockdown or collapsible folding cartons from a plurality of pieces.

2,625,096. Paper carton collapser. Walter G. Peterson. Filed Nov. 2, 1950. 1 claim. (Cl. 100-76.) Paper carton collapser that crushes paper milk cartons and folds them into a small space for convenient disposal.

2,625,224. Paper-cutting mechanism. Elmer E. Garrett, assignor to The Sperry Corp. Filed Jan. 17, 1951. 5 claims. (Cl. 164-68.) Machine utilizes a pair of vertically opposed, rapidly rotating cutting rolls and a web feeding mechanism which feeds in timed relation to the rotation of the rolls.

2,625,315. Carton. Emil W. Fehrenkamp, assignor to Burd & Fletcher Co. Filed March 28, 1949. 1 claim. (Cl. 229-45.) Collapsible carton (for popcorn, etc.), easily assembled for use at concession stands with locking tab in top closure.

2,625,316. Telescoping box with cover fastener. John H. Stortz. Filed Nov. 18, 1949. 1 claim. (Cl. 229-45.) Mailing box with adhesive fastening tabs.

2,625,317. Container. Chester M. MacChesney, assignor to Acme Steel Co. Filed May 24, 1945. 1 claim. (Cl. 229-47.) Fiber-drum container for packaging powdered or granular materials.

2,625,318. Bag with handles. Lawrence T. Ross, assignor to Union Bag & Paper Corp. Filed May 29, 1946. 3 claims, (Cl. 229-54.) Method for stitching paper handles to the closed end seam of multi-ply bags.

2,625,464. Roasting of sulphides. Elliott J. Roberts, Rupert M. Foley, and David F. Wells, assignors to The Dorr Co. Filed May 24, 1949. 4 claims. (Cl. 23-177.) Process for producing sulphur trioxide- and sulphur-free sulphur dioxide gas from pyrite.

2,625,474. Acid-alkali process for the preparation of cellulose fibers. James D. Atkinson, Jr., and Linwood N. Rogers, assignors to Buckeye Cotton Oil Co. Filed June 30, 1947. 3 claims. (Cl. 92-9.) An eight-step process for pulping bagasse; this process can be used for the best grades of paper and viscose rayon.

2,625,496. Decalcomania for metal transfers. Donald D. Swift and John J. Kohler, assignors to M. Swift & Sons, Inc. Filed Sept. 30, 1950. 6 claims. (Cl. 154-46.8.) A decalcomania for the application of metal decorations to smooth or irregular surfaces.

2,625,517. Coagulation of oil emulsions with cellulose sulphate. John B. Caldwell, assignor to Eastman Kodak Co. Filed Oct. 19, 1951. 6 claims. (Cl. 252–332.)

January 20, 1953

2,626,239. Drilling fluids and methods of using same. Cary

R. Wagner, William N. Axe, and Chester M. Himel, assignors to Phillips Petroleum Co. Filed July 28, 1949. 12 claims. (Cl. 252-8.5.) Process for making and using a water-base well drilling mud comprised of an aqueous fluid mixture containing suspended inorganic solids and a water-soluble sulphonated cellulose derivative.

2,625,695. Sleeping bag made of paper. James W. Nicholson. Filed June 12, 1950. 6 claims. (Cl. 5-343.) Expendable sleeping bag with outer covering of durable, waterproof, crinkled paper, inner lining of durable crinkled paper, and a filler of many layers of thin crinkled paper.

2,625,775. Art of packaging with pull strip. Bernard J. Tamarin and Adolph Meletti. (Meletti assignor to Tamarin.) Filed Aug. 16, 1946. 18 claims. (Cl. 53-5.) Cellophane pull strip applied to cigarette package.

2,625,777. Packaging machine and method of packaging. Clarence J. Malhiot, assignor to F. B. Redington Co. Filed April 2, 1949. 20 claims. (Cl. 53-136.) Machine for continuous packaging of 2, 4, or 6 cans in one carton.

2,625,778. Machine for closing cartons while the cartons are being translated. Wayne A. Wood, assignor to Sutherland Paper Co. Filed May 21, 1951. 20 claims. (Cl. 53-145.) Machine automatically closes rectangular paper cartons while they are on a moving conveyor belt.

2,625,779. Paper feeding mechanism for box wrapping machines. Clarence J. Peterson, assignor to Bank of America National Trust and Savings Assoc. Filed March 4, 1950. 5 claims. (Cl. 53-155.)

2,625,862. Bag handle making and applying machine. William H. Bokenkroger and True M. Avery, assignors to Union Bag & Paper Corp. Filed May 5, 1947. 17 claims. (Cl. 93-8.) Machine makes multi-ply handles from single-ply strips and attaches them to preformed shopping bags.

2,625,968. Mechanical log barker. Henrik J. Eklund and Clarence W. Miller, assignors to D. J. Murray Manufacturing Co. Filed April 21, 1949. 5 claims. (Cl. 144-208.) Log barker which mechanically twists and removes the bark from longitudinally advancing logs by a series of helically disposed revolving elements in a rotor.

2,625,978. Insulated shingle producing machine. Robert Patterson, assignor to Multi Shingle Corp. Filed March 23, 1949. 16 claims. (Cl. 154-1.6.) Machine improvements include a conveyor mechanism which moves the insulation slabs singly from a stack past an adhesive-coating applicator.

2,626,012. Feed control for paper filters. Lawrence M. Persons, assignor to McQuay-Norris Manufacturing Co. Filed May 19, 1947. 5 claims. (Cl. 183-62.) Paper filters in an air conditioning can be automatically changed by an electrically operated means.

2,626,050. Folding shipping frame for glass. James M. Freiberg, assignor to Pittsburgh Plate Glass Co. Filed Jan. 8, 1952. 14 claims. (Cl. 206-62.) An extensible cushioning edge packing for plate glass made from paper board without the use of adhesive or metal.

2,626,077. Separator for cartridge cartons. Richard C. Marshall, assignor to Mars-Hall, Inc. Filed Nov. 13, 1952. 1 claim. (Cl. 217-28.) A series of tabs so folded that when the cartridges are removed the tabs stay in position.

2,626,095. Consumer type container. Lewis C. Brooks, assignor of one third to Ira M. Jones. Filed Oct. 29, 1948. 1 claim. (Cl. 229–23.) A water-, vaporproof container that can be partially fabricated and shipped flat.

2,626,096. Frangible means for dispensing cartons. Robert J. Hickin, assignor to The Ohio Boxboard Co. Filed May 20, 1949. 1 claim. (Cl. 229-51.) An opening for dispensing cleansing tissues, etc.

2,626,097. Envelope fastener means. Walter H. McConnoughy. Filed Nov. 7, 1949. 1 claim. (Cl. 229-77.) An envelope fastener comprising a stationary riveted button on the back fold of the envelope and a "button hole" on the closure flap.

2,626,145. Tissue interfolding method and apparatus. Reinhardt N. Sabee, assignor to International Cellucotton Products Co. Filed April 5, 1947. 11 claims. (Cl. 270-73.) The adaption of a high-speed rotary interfolding machine for the continuous Z-folding of facial tissue.

2,626,147. Jogging device for piled sheets. Nils Gjostein, assignor to Federal Carton Corp. Filed June 9, 1949. 5 claims. (Cl. 271-8.) An inexpensive jogging device that permits accurate feeding of cardboard sheets into machines for cutting, scoring, etc.

2,626,213. Asbestos dispersions and method of forming same. Izador J. Novak, assignor to Raybestos-Manhattan, Inc. Filed Dec. 21, 1948. 14 claims. (Cl. 92-3.) Method produces high-strength smooth paper webs.

2,626,214. Paper from long synthetic fibers and partially water-soluble sodium carboxymethylcellulose and method. Fay H. Osborne, assignor to C. H. Dexter & Sons, Inc. Filed June 14, 1949. 13 claims. (Cl. 92-3.) Absorbent, porous, lightweight web material (for tea bags, etc.) made of various synthetic fibers.

2,625,295. Dry cell battery. Allison M. MacFarland, assignor to General Dry Batteries, Inc. Filed April 19, 1950. claim. (Cl. 136-111.) Casing for multiple-cell batteries for use in hearing aids, etc.

January 27, 1953

2,626,494. Packaging machine. Harold P. Lewis, assignor to Pak-Rapid, Inc. Filed April 13, 1950. 3 claims. (Cl. 53-86.) A package-forming and -sealing machine for packaging solid and granular articles.

2,626,543. Fluid pressure sealed garter strap for cylinder molds. Loyd Hornbostel, assignor to Beloit Iron Works. Filed Oct. 27, 1948. 5 claims. (Cl. 92-43.) Fluid pressure brings a sealing ring into contact with the circular end faces of a rotatable cylinder mold to form a liquid-tight seal.

2,626,544. Apparatus for and process of manufacturing enwrapments. Clarence W. Vogt. Filed July 29, 1948. 23 claims. (Cl. 93-1.) Method and apparatus for making from flattened tubular casing a plurality of bags connected in chained relationship.

2,626,545. Apparatus for setting up box blanks. Rolf A. Samsing, assignor to Carton Engineering Corp. Filed Oct. 11, 1951. 2 claims. (Cl. 93-51.)

2,626,703. Match package. Harry G. Watson, Filed Oct. 27, 1949. 4 claims. (Cl. 206-29.) A conical container to hold wooden-stem matches.

2,626,715. Log handling boom. Charles H. Sparks and Frank C. Turner. Filed June 8, 1951. 2 claims. (Cl. 212-144.) Portable log-handling apparatus with improved boom.

2,626,739. Folding box. Herman A. Feigelman. Filed Jan. 31, 1947. 2 claims. (Cl. 229-27.)

2,626,864. Building board of fiber and asphalt coated perlite. Jack Miscall and Chester E. Rahr, assignors to Great Lakes Carbon Corp. Filed Dec. 31, 1947. 3 claims. (Cl. 92-3.) Process for making waterproof, fireproof, and high wet strength board.

2,626,872. Asphalt building board. Jack Miscall, assignor to Great Lakes Carbon Corp. Filed June 2, 1948. 1 claim. (Cl. 106-122.) A high heat- and sound-insulation board made of a bituminous binder and a filler of 35–57% expanded perlite.

2,626,884. Carbon paper. William M. Ewing, assignor to the United States of America as represented by the Secretary of the Navy. Filed June 17, 1946. 2 claims. (Cl. 154-53.6.) A smoked recording paper for a stylus recording instrument.

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2,627,145. Conformable abrasive-coated sheet material. Rudolph S. Frigstad, assignor to Minnesota Mining & Manufacturing Co. Filed Aug. 13, 1948. 4 claims. (Cl. 51-185.) A highly flexible, waterproof sandpaper of an x-creped kraft paper-base sheet and resinous impregnating and strengthening agent.

2,627,150. Package forming and sealing machine. Vao L. Cheney and Max E. Toby, assignors to Chip Steak Co. Filed May 31, 1949. 10 claims. (Cl. 53-25.) Machine rapidly forms and separates hermetically sealed envelops from cellophane, latex-coated paper, or the like.

2,627,152. Automatic carton closing machine. Bertie S. Harrington, assignor to Armour and Co. Filed March 13, 1948. 60 claims. (Cl. 53-44.) A high-speed, easily operated machine for closing lard boxes and the like.

2,627,153. Banding of roofing material. Felix Stencil, assignor to Lloyd A. Fry Roofing Co. Filed Dec. 16, 1948. 11 claims. (Cl. 53-59.) An assembly-line packaging apparatus for applying fiberboard wrapping to stacks of roofing shingles.

2,627,154. Wrapping machinery. Alfred G. Rose and Frederick H. Pearson, assignors to Rose Brothers (Gainsborough) Ltd. Filed April 20, 1950. 4 claims. (Cl. 53-124.) A machine for wrapping cellulosic material around cigarette packages or the like.

2,627,211. Machine for pressing pulp articles. Merle P. Chaplin, assignor to Chaplin Corp. Filed Oct. 18, 1949. 4 claims. (Cl. 92-59.)

2,627,350. Filter cartridge. John D. Wicks, assignor to Wix Accessories Corp. Filed Jan. 12, 1949. 5 claims. (Cl. 210-169.) An improved filter cartridge for use in the lubricating systems of internal combustion engines.

2,627,375. Separation of bark components. Bror L. Grondal and Calvin L. Dickinson, assignors to Weyerhaeuser Timber Co. Filed Jan. 5, 1948. 14 claims. (Cl. 241-14.) Method of treating coniferous bark for the production of cork, fiber, and powder residue.

2,627,427. Fanfolded paper label strip. Joseph Weimont, assignor to A. Kimball Co. Filed Aug. 7, 1951. 1 claim. (Cl. 281-5.) A fanfolded paper label strip comprising a series of separable labels.

2,627,470. Package. Oscar E. Seiferth, assignor to Voss Brothers Manufacturing Co. Filed July 7, 1945. 6 claims. (Cl. 99-175.) A continuous strip of banding paper for packaging sausages and like products.

2,627,472. Frozen confection package and container therefor. Joseph Valenta. Filed July 17, 1951. 7 claims. (Cl. 99-180.) A cardboard container whose locking means also serves as a drip catcher for ice cream on a stick.

2,627,484. Corrugated paper. Paul Brown, assignor to Packaging Materials Corp. Filed March 30, 1951. 4 claims. (Cl. 154-55.) A molded sheet having substantially thicker spaced corrugations for packaging fragile articles.

2,627,500. Distillation of fatty acids, tall oil, and the like. Ralph H. Potts, and Ray N. Olson, assignors to Armour and Co. Filed Dec. 15, 1947. 9 claims. (Cl. 202-46.)

2,627,514. Blown tall oil reaction products. Willard H. Kirkpatrick and Earl T. Kocher, assignors to Visco Products Co. Filed March 16, 1951. 4 claims. (Cl. 260-97.5), The product made is water wettable, interfacial and surface active, and can be used to resolve water in oil-petroleum emulsions.

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2,627,711. Wrapper crimping apparatus. Victor V. Dixon. Filed April 30, 1951. 1 claim. (Cl. 53-150.) An adjustable pair of spaced, parallel crimping members mounted on an inclined base plate.

2,627,788, Paper machinery. Stephen A. Staege, assignor to The Black-Clawson Co. Filed Feb. 12, 1948. 20 claims. (Cl. 92-44.) A control device to regulate the freeness and consistency of the papermaking stock, particularly as supplied to a paper machine or refiner.

2,627,789. Suction box. John Campbell. Filed April 10, 1950. 10 claims. (Cl. 92-51.) This box features an improved wire support mechanism and seal device.

2,627,790. Blade packaging machine. Zemach Auerbach assignor to The Gillette Co. Filed Aug. 26, 1948. 18 claims. (Cl. 93-1.) A machine for packaging razor blades.

2,627,791. Device for setting up cartons. William A. Ringler, assignor to The Gardner Board and Carton Co. Filed Oct. 24, 1947. 9 claims. (Cl. 93-51.) In single movement machine sets up carton for three lamp bulbs at point of testing.

2,627,792. Envelope patch applying mechanism. Abraham Novick, assignor to F. L. Smithe Machine Co., Inc. Filed Aug. 30, 1950. 12 claims. (Cl. 93-61.) An apparatus for manufacturing window envelopes.

2,627,858. Disposable diaper. Margaret E. Miller. Filed Nov. 3, 1950. 9 claims. (Cl. 128-287.) Paper diaper with adhesive fastener tabs.

2,627,922. Machine for cutting tissue. Oliver E. Teall, assignor one third to William Edds and one third to Douglas Crutchley. Filed Feb. 14, 1950. 11 claims. (Cl. 164-61.) Machine with circular cutters for use on tissues, paper toweling, etc.

2,627,971. Detachable ash try for match packs. Ray H. Garber. Filed Dec. 6, 1950. 1 claim. (Cl. 206-37.) Cardboard tray with inwardly facing grooves for match pack.

2,627,972. Sample dispensing device. Raymond B. Roos. Filed May 6, 1948. 1 claim. (Cl. 206-44.11.) A sales package display incorporating an open sample package which stays in place when surrounding packages are removed by the consumer.

2,627,974. Facial tissue. Marion Donovan. Filed April 6, 1951. 6 claims. (Cl. 206-57.) Multiple plies of a facial tissue are stacked to permit withdrawal of a single ply or an entire tissue from the box.

2,628,012. Paperboard carton with cover. Morton Goldshall, assignor to Container Corporation of America. Filed May 26, 1950. 3 claims. (Cl. 229-44.) A carton with hollow, double panel structure walls and a separate cover panel extending over the top which can be raised to provide a display panel.

2,628,013. Article for packaging materials. Clarence W. Vogt. Filed June 2, 1948. 1 claim. (Cl. 229-53.) Bags in pairs for packaging liquids, pastes, etc.

2,628,110. Carbon set form. Frank J. Hauer. Filed Jan. 31, 1949. 2 claims. (Cl. 282-22.) A carbon set form with means for separating the paper and carbon transfer sheets along one edge of the form.

2,628,155. Method for the recovery of spent liquors from the cooking of cellulose from raw material containing silica. Bengt H. E. Gruen. Filed Feb. 1, 1949. 5 claims. (Cl. 23-46.)

2,628,179. Method of producing cartons having metal tearing edges. Robert M. Bergstein. Filed Feb. 1, 1950. 14 claims. (Cl. 154-118.) A carton for dispensing wax paper, etc., with narrow, metal tearing strip.

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2,628,433. Yankee drier. Harry M. Ostertag, assignor to Scott Paper Co. Filed May 25, 1950. 10 claims. (Cl. 34-124.)

2,628,541. Machine for making filter and like tips for cigarettes. Hedwig Gamble. Filed Nov. 8, 1950. 6 claims. (Cl. 93-1.)

2,628,542. Adjustable conveyer for cartoning machines. Alexander H. Ross, assignor to Emhart Manufacturing Co. Filed Sept. 17, 1945. 4 claims. (Cl. 93-49.) An adjustable packaging machine for erecting cartons from flat-folded blanks by a squeezing action exerted by fingers which constitute part of a continuous conveyor.

2,628,543. Box-blank cutting assembly. Daniel Bartlette and Edward C. Lowe. Filed Dec. 11, 1950. 7 claims. (Cl. 93-58.) Assembly features the cutting of box blanks of different flap widths in one operation.

2,628,560. Molded pulp wad. Walter H. Randall, assignor to Keyes Fibre Co. Filed Jan. 26, 1952. 2 claims. (Cl. 102-95.) A suction-molded cylindrical pulp wad for use in shot shells and small arms ammunition.

2,628,619. Jacket for phonograph records. Rudolph A. Froehlig, assignor to Modern Record Albums, Inc. Filed June 12, 1952. 4 claims. (Cl. 129-16.7.) A cardboard jacket for long-playing records with a hinged tab for recording record identification.

2,628,640. Pulp molding machine and process. Walter H. Randall, assignor to Keyes Fibre Co. Filed Feb. 26, 1946. 5 claims. (Cl. 92-56.) Machine for forming molded-pulp articles such as cylindrical shotgun shell wads.

2,628,656. Manufacture of creped paper. Allan B. Stevenson, assignor to American Reenforced Paper Co. Filed July 29, 1950. 2 claims. (Cl. 154-30.) Method and apparatus for creping paper to impart stretchability in all directions.

2,628,680. Guillotine knife-automatic electrical back gauge. Frederick W. Seybold, assignor to E. P. Lawson Co., Inc. Filed Sept. 2, 1949. 10 claims. (Cl. 164-48). An automatic, photoelectrically controlled back gage-spacing mechanism which adjusts the back gage of guillotine-type paper cutters.

2,628,681. Web perforating mechanism. Gideon Kane. Filed Feb. 3, 1951. 2 claims. (Cl. 164-99.) A perforating mechanism for a traveling web of sheet material.

2,628,761. Attachable closure for containers. Charles R. Yancey, assignor 45% to Katherine Knapp Yancey and 10% to E. Hastings Ackley. Filed Aug. 20, 1949. 6 claims. (Cl. 229-7.) A one-piece closure attachment made of sheet cardboard or plastic designed for use on the side wall of folding or setup cartons.

2,628,762. Carton. Richard O. Spalding, assignor to Owens-Illinois Glass Co. Filed June 21, 1949. 1 claim. (Cl. 229-15.) A corrugated rectangular paperboard carton with partition strips for shipping glassware.

2,628,763. Carton. William P. Frankenstein. Filed Jan. 3, 1947. 14 claims. (Cl. 229-31.) Knockdown cartons of the hollow-wall type strengthened by one or more transverse ribs or braces which prevent inward bulging.

2,628,764. Ready wrapper. Matthew N. Rubinstein and Stuart Chaplin, assignors to Auto-Wrap Corp. Filed Sept. 23, 1946. 6 claims. (Cl. 229-53.) Bag-type paper wrapper for wrapping one or more prismatic-shaped objects.

2,628,907. Method of packaging material. Edna A. Darden. Filed Sept. 7, 1951. 1 claim. (Cl. 99-171.) A paper carton with telescoping measuring device for freezing and storing food.

2,628,917. Thermoplastic resins formed from pinewood pitch. Thomas R. McElhinney and Thomas D. Woodruff, assignor to Valite Corp. Filed Oct. 11, 1949. 24 claims. (Cl. 106-222.) This resin made from pinewood pitch can be used as a substitute for shellac as a binder in phonograph records.

2,628,918. Sizing agents. William S. Wilson and Albert H. Bump, assignors to Monsanto Chemical Co. Filed May 6, 1952. 9 claims. (Cl. 106-238.) A paper-sizing adjunct consisting of an acidic organic compound (maleic anhydride) is combined with rosin.

2,628,946. Fire-retardant composition containing an anion exchange resin. Walter Juda, Grinnell Jones, and Nathaniel Altman, assignors to Albi Manufacturing Co. Filed May 22, 1946. 14 claims. (Cl. 260-15.)

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2,629,182. Paper cutter for paper mill drying rollers. John C. Nix, III. Filed Feb. 4, 1948. 9 claims. (Cl. 34-85.) A rotating cutting device for cutting broke from any of the rolls in a drier section.

2,629,254. Tensile strength tester. H. M. Brown, assignor to Clemson Agricultural College of South Carolina. Filed June 27, 1950. 15 claims. (Cl. 73-90.) Tester for use in textile industry.

2,629,295. Method of making paper. George A. Richter and Robert H. MacClaren, assignors to Eastman Kodak Co. Filed June 15, 1945. 4 claims. (Cl. 92-20.) Method for making a paper of good flatness and uniform formation suitable for photographic paper.

2,629,390. Sanitary underwear liner. Edward W. Schweikert. Filed Oct. 31, 1950. 1 claim. (Cl. 128-284.) Disposable soft paper lining for use in underwear.

2,629,423. Machine for fabricating laminated signatures provided with sheet metal inserts. Donald B. Loeser, assignor to

The Sorg Paper Co. Filed Dec. 9, 1949. 9 claims. (Cl. 154-1.6.)

2,629,440. Automatic paper-cutting machine. James M. Shaw and Leslie I. Faus, assignors to Harry Rosenthal. Filed July 11, 1946. 20 claims. (Cl. 164-49.) A paper-cutting machine mounted on a table that feeds paper automatically from a roll onto the table and cuts off the paper at the desired length by a combined electrical and pneumatic control.

2,629,533. Molded fiber article. Merle P. Claplin, assignor to Chaplin Corp. Filed April 18, 1945. 2 claims. (Cl. 229-2.5.) A molded pulp article for use as a cup, dish, etc.

2,629,535. Tray or carton. Fred. J. Ullrich, assignor to Sutherland Paper Co. Filed Feb. 18, 1949. 2 claims. (Cl. 229-34.) A tray or carton which can be easily and quickly erected by securing the sides in their upright position by a series of reinforcing flaps extending from the ends of each wall part.

2,629,612. Carbon paper holder. Vincent J. St. John. Filed June 11, 1949. 2 claims. (Cl. 282-29.) A heavy paper or cardboard carbon-paper holder with hinged tabs which interlock in slits in the carbon paper permitting easy insertion and removal of typing paper.

2,629,648. Impregnated fibrous wallboard and method of making. Walter P. Ericks, assignor to The Upson Co. Filed July 7, 1949. 19 claims. (Cl. 8-115.6.) Method of stabilizing fiber wallboards against expansion and contraction with changes in atmospheric humidity.

2,629,649. Vapor-phase corrosion inhibitor. Aaron Wachter and Nathan Stillman, assignors to Shell Development Co. Filed Oct. 31, 1949. 20 claims. (Cl. 21-2.5.) Paper, cardboard, cloth, etc., are treated to provide corrosion-inhibiting wrapping materials for ferrous metals.

2,629,674. Method of treating cellulose and product thereof. Walter P. Ericks, assignor to The Upson Co. Filed July 7, 1949. 8 claims. (Cl. 117-140.) Method of stabilizing fiber wallboards against expansion and contraction with changes in atmospheric humidity.

2,629,699. Modified starch-urea-formaldehyde water resistant adhesive. Edward E. Moore, assignor to Stein, Hall and Co., Inc. Filed Oct. 20, 1949. 13 claims. (Cl. 260-17.3.) Adhesive for paper-bag seams.

2,629,701. Compositions containing esters of a glycol and polycarboxylic acids and the treatment of cellulose therewith. Walter P. Ericks, assignor to The Upson Co. Filed May 27, 1949. 14 claims. (Cl. 260-29.3.) Composition to stabilize cellulose-fiber product (wallboard).

2,629,808. Apparatus for sealing wrapping material. Lawrence A. Ulmschneider, assignor to Eastman Kodak Co. Filed Nov. 15, 1950. 6 claims. (Cl. 219-19). Apparatus for sealing wrapping paper that is coated with aluminum foil on one side and polyethylene on the other.

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2,629,977. Package top sealing apparatus. John Riemer, assignor to Kraft Foods Co. Filed Nov. 4, 1947. 5 claims. (Cl. 53-144.) Apparatus for sealing open-topped paperboard packages with thermoplastic inner liners.

2,630,044. Paper stock distributor for beaters. Frank Hayes, assignor to Noble & Wood Machine Co. Filed June 21, 1948. 3 claims. (Cl. 92-22.)

2,630,045. Papermaking apparatus. Benjamin E. Teale. Filed June 21, 1950. 1 claim. (Cl. 92-44.) A slice of unitary construction which may be located as desired along the pond plates is rigid and strong without losing necessary flexibility.

2,630,047. Former for cartons. T. Rowlands. Filed June 5, 1951. 1 claim. (Cl. 93-77.) A grooved former for cartons to accommodate creases in the carton material and sides of a shallow concave surface to permit the ready removal of the finished carton from the former.

2,630,153. Hydraulic support for log debarking drum. George M. Dick, assignor to Ingersoll-Rand Co. Filed March 11, 1952. 6 claims. (Cl. 144-208.) A rotatable debarking drum mounted in a tank containing washing fluid is supported by shoes having grooved bearing surfaces in sliding contact with tires mounted on the drum.

2,630,262. Watertight and gastight shipping container. Samuel Bergstein. Filed July 16, 1948. 4 claims. (Cl. 229-3.1.) A corrugated or fiberboard shipping container covered with moisture-, vapor-, and gastight sleeve seamed to itself with a second kraft paper or board sleeve covering the first.

2,630,263. Container. William A. Ringler, assignor to The Gardner Board and Carton Co. Filed Aug. 31, 1945. 6 claims. (Cl. 229-31.) A polygonal, liquid-tight, self-locking paperboard container for frozen foods, ice cream, etc., made from a single creased blank.

2,630,264. Bottle carrier. Mitchel E. Holy, assignor to Container Corporation of America. Filed April 19, 1949. 1 claim. (Cl. 229-39.) A collapsible, bottle carrier-type paperboard carton in the form of an elongated tube with enclosure elements at each end and finger openings for carrying purposes.

2,630,265. Display carton. Thomas L. Hellawell, assignor to Tuk-Bak Trays, Inc. Filed Aug. 3, 1948. 3 claims. (Cl. 229-41.) Collapsible cardboard display cartons for fruits, vegetables, etc., from a single blank.

2,630,368. Vapor phase inhibitors of corrosion. Aaron Wachter and Nathan Stillman, assignors to Shell Development Co. Filed June 1, 1946. 18 claims. (Cl. 21-2.5.) Kraft paper impregnated with morpholine nitrite is wrapped around normally corrodible ferrous metal and overwrapped with metal foil.

2,630,397. Method of bonding sheet materials and coating compositions therefore. John C. Cowan, Lee B. Falkenburg, and Arthur J. Lewis, assignors to the United States of America as represented by the Secretary of Agriculture. Filed Dec. 27, 1948. 13 claims. (Cl. 154-138.) A coating composed of fatty acids, resins, and paraffin wax for moisture-, vaporproofing cellulosic sheet materials.

2,630,454. Dibasic ether acid derivatives of vanillic acid. Louis H. Block, assignor to Rayonier, Inc. Filed Nov. 28, 1950. 1 claim. (Cl. 260-520.)

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2,630,602. Coconut husk defibering machine. Martiniano Floro. Filed April 25, 1947. 4 claims. (Cl. 19-12.) Rotary conical scrapers remove coconut coir dust and short fibers from the husks of the nuts and so separate the clean bristle fibers as well as spinnnable coir fibers.

2,630,742. Device for opening shells of slide and shell cartons. Charles T. Hall, assignor to Molins Machine Co., Ltd. Filed Jan. 23, 1950. 3 claims. (Cl. 93-53.) Device for opening flattened cigarette cartons.

2,630,848. Hydraulic log barking apparatus. Miles L. Edwards, assignor to Weyerhaeuser Timber Co. Filed July 5, 1947. 11 claims. (Cl. 144-208.) Logs debarked in one continuous operation by direct jets of water coming from one or more nozzles mounted in a barking chamber.

2,630,879. Dust collecting bag and filter for vacuum cleaners. Hildur Hage. Filed April 15, 1950. 1 claim. (Cl. 183-51.) Disposable paper bag with permanent or detachable cellulose filter can be secured to vacuum cleaner casing either adhesively or with holding device.

2,630,901. Apparatus for feeding webs of paper. William E. Johnson and Hubert J. Hillen, assignors to Powers-Samas Accounting Machines Ltd. Filed Dec. 2, 1950. 9 claims. (Cl. 197-133.) Plain or perforated webs of paper can be fed to statistical machines by the detachable feeding apparatus utilizing a rotatable platen for the former and a pin type for the latter.

2,630,911. Protection of packages. Geoffrey V. B. Herford and Thomas A. Oxley. Filed April 1, 1949. 12 claims. (Cl. 206-10.) An insect-destroying packaging material comprising labyrinthine layers of cellulose wadding, some of which may be impregnated with an insecticide.

2,630,934. Cylindrical container. Armin Elmendorf. Filed July 31, 1948. 9 claims. (Cl. 217-1.) A blank for a tubular container includes a layer of wood veneer between two layers of paper and flexible metal-sheet straps for assembling the container.

2,630,948. Insert board. Benjamin Liebowitz, assignor to Trubenizing Process Corp. Filed Aug. 5, 1950. 6 claims. (Cl. 223-71.) A folding insert board for men's shirts.

2,630,949. Collar protector for soft shirts. James W. Steele. Filed Aug. 23, 1948. 1 claim. (Cl. 223-83.) A one-piece inverted-V type cardboard brace with or without a front shirt-engaging tab.

2,630,962. Carton. Paul Wasyluka, assignor to Gaylord Container Corp. Filed Oct. 15, 1949. 7 claims. (Cl. 229-31.) Hinged-cover paperboard cartons for shipping and/or storing vegetables made from single blanks that require only one staple at each corner fold.

2,631,046. Foldable adjustable and mailable advertising display. Charles A. Stephens. Filed Jan. 9, 1952. 1 claim. (Cl. 283-56.)

2,631,087. Sulphur recovery process. Lyle K. Herndon, assignor to The Fluor Corp., Ltd. Filed Aug. 2, 1950. 3 claims. (Cl. 23-226.) Sulphur containing gases are preheated and the sulfur dioxide reduced by incandescent coke, the vapor mixture is then catalytically converted by aluminum oxide to sulphur.

2,631,097. Method of producing cellulose mass and product. Donald V. Redfern, assignor to American-Marietta Co. Filed Nov. 4, 1948. 20 claims. (Cl. 92-21.) A method for forming a cellulose-fiber product (wet-strength papers, wallboards, insulating and hardboards, etc.) and a thermosetting, insoluble, infusible phenol-aldehyde resin.

2,631,098. Production of thermosetting phenol-aldehyde resin condensation products. Donald V. Redfern, assignor to American-Marietta Co. Filed Nov. 4, 1948. 35 claims. (Cl. 92-21.) An alternative method for making the thermosetting phenol-aldehyde resin adhesive claimed in U. S. Patent 2,631,097.

2,631,131. Stabilized compositions containing sulphurized

esters of tall oil. Stanley P. Waugh, assignor to Tide Water Associated Oil Co. Filed April 19, 1950. 21 claims. (Cl. 252-32.7.)

2,631,129. Sulfurized tall oil-containing compositions. Stanley P. Waugh, assignor to Tide Water Associated Oil Co. Filed June 2, 1952. 20 claims. (Cl. 252-32.7.)

2,631,144. Activation of cellulose. Lejaren A. Hiller, Jr., assignor to E. I. du Pont de Nemours and Co. Filed Oct. 23, 1950. 7 claims. (Cl. 260-229.)

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2,631,381. Apparatus for making wallboard. Eastman A. Burrows, assignor to S. D. Libbey. Filed July 10, 1947. 3 claims. (Cl. 34-144.) Wallboards produced as green or uncured sheets and formed by the introduction of a plastic material to be intumesced between paper liners.

2,631,417. Apparatus for forming paper crackers. Edgar Harrison, assignor to Tom Smith & Co., Ltd. Filed Dec. 5, 1949. 7 claims. (Cl. 53-92.) Continuous, automatic machine for making paper party favors.

2,631,439. Refrigerating shipping container for frozen foods. David L. Feigenbaum, assignor to Little America Frozen Foods, Inc. Filed Jan. 28, 1950. 5 claims. (Cl. 62-91.5.) Fiberboard or corrugated paperboard container comprising upper and lower telescoping parts forming a complete enclosure.

2,631,504. Rotary refiner. Edmund P. Arpin, Jr., and Raymond P. Frye. (Frye's interest assigned to Arpin.) Filed July 7, 1948. 11 claims. (Cl. 92-26.) Each rotor stone is held in a housing or backing plate by a number of adjustable wedge-shaped members which are securely fastened in place; a pressure pad between the stone and several wedge members assures uniform application of pressure.

2,631,505. Rotary refiner liner construction. E. P. Arpin, Jr., and Raymond P. Frye. (Frye's interest assigned to Arpin.) Filed Aug. 10, 1948. 2 claims. (Cl. 92-26.) A liquid-cooled abrasive liner comprising a number of half-ring members which are bonded to a semicylindrical backing member.

2,631,506. Vibratory rotary screening mechanism. Nils W. Jönsson and Karl O. Lindgren, assignors to Aktiebolaget A. Ekströms Maskinaffär. Filed Oct. 29, 1946. 3 claims. (Cl. 92-36.) Stresses on the screen construction are reduced by elastically mounting the nonvibrating base or vat on springs or the like.

2,631,507. Paper web straightening device. John J. Schwab and Otto Wahl, assignors to W. J. Bradford Paper Co. Filed Jan. 31, 1948. 1 claim. (Cl. 92-70.)

2,631,508. Web pleating and cutting machine. A. A. Muehling, assignor to Bendix Aviation Corp. Filed Sept. 24, 1948. 16 claims. (Cl. 93-1.) Machine for fabricating filter elements from paper sheet material, creases, pleats, cuts into desired lengths, folds pleated sheet into hollow article, trims and cuts to desired size.

2,631,509. Method for forming tubular articles. Graeme G. Whytlaw, assignor to American Viscose Corp. Filed July 18, 1944. 3 claims. (Cl. 93-94.) Method for making tubes used primarily for wrapping wound packages of textile material preparatory to liquid treatment of the packages.

2,631,528. Machine for printing erected cartons. Wayne A. Wood, assignor to Sutherland Paper Co. Filed Aug. 29, 1949. 4 claims. (Cl. 101-44.) Can be used in connection with a carton-erecting machine and stamps carton as it move by on a conveyor.

2,631,562. Apparatus for preparing and dispensing adhesive coated tape. George A. Gerard. Filed June 2, 1950. 8 claims. (Cl. 118-43.) Dispenser includes a roll for the tape, means for applying a pressure sensitive substance to one side of the tape as it leaves the roll, and tape guides to aid in extraction.

2,631,589. Reinforced folder. Philip Zalkind. Filed Oct. 17, 1944. 3 claims. (Cl. 129-16.7.) Paper or fiber file folders reinforced by folding multiple creases in the upper edge of either or both panels to form a removable tab-holding groove.

2,631,593. Hair curling paper. Arthur H. Madore. Filed Jan. 2, 1951. 1 claim. (Cl. 132-36.2.) Hair-curling paper with a series of projections on one side which act as a comb and corresponding indentations on the other side which act as minute curling oil cups.

2,631,642. Box sealing method and apparatus. Ralph R. Richardson, Walter T. Ritter, Robert O. Ragan, and Don W. Coy. Filed July 22, 1949. 17 claims. (Cl. 154-1.) An automatic, continuous package-sealing apparatus for rectangular cartons.

2,631,644. Thermal insulating material and method of making the same. Thomas D. Cole, assignor to Lockport Cotton Batting Co. Filed May 7, 1949. 8 claims. (Cl. 154-28.) Building insulation panels or batts made of films or webs of matted fibrous material divided into alternate zones, parallel to each other and crosswise of the direction of feed of the webs.

2,631,721. Hat packing box. L. P. Sommerhauser. Filed Feb. 28, 1952. 3 claims. (Cl. 206-8.) A hat-storage and -shipping container for one or more felt hats so arranged that the crowns will not hit the bottom nor the brims hit the sides.

2,631,723. Corner cushioning packaging device. Harold I. Ellsworth. Filed Dec. 8, 1949. 3 claims. (Cl. 206-60.) Cardboard package protector with rounded edges provides cushion along the bending lines and corners to prevent damage during transport.

2,631,724. Tray. Ernest C. Wright, assignor to Union Bag & Paper Corp. Filed June 2, 1950. 4 claims. (Cl. 206-65.) Corrugated board trays for shipping and supporting cones of yarn.

2,631,732. Fiber disk filter assembly. John Vocelka, assignor to Wm. W. Nugent & Co., Inc. Filed Nov. 8, 1950. 3 claims. (Cl. 210-169.) A filter stack of concentric filter disks (paper, pulp, etc.).

2,631,733. Method and apparatus for the continuous screening of fluids. Carl H. Rowe and Elmer R. Mokros, assignors to K-C-M Co. Filed Oct. 9, 1947. 9 claims. (Cl. 210-198.)

2,631,767. Packaging machine. Charles T. Banks, assignor to International Cellucotton Products Co. Filed Feb. 21, 1948. 23 claims. (Cl. 226-14.) Machine for packaging sanitary napkins and the like.

2,631,772. Container. Walter Hiersteiner, assignor to Tension Envelope Corp. Filed April 6, 1949. 1 claim. (Cl. 229-68.) A paper boxlike container for greeting cards, etc.

2,631,773. Mailing sheet. Harry B. Coffin. Filed Aug. 9, 1946. 4 claims. (Cl. 229-92.1.) A combination letter, booklet, order blank, and reply envelope.

2,631,846. Delivery mechanism for tissue interfolding apparatus. Reinhardt N. Sabee, assignor to International Cellucotton Products Co. Filed May 13, 1949. 4 claims. (Cl. 270-39.) Apparatus can rapidly Z-fold or interfold tissue paper, creped tissue paper, and double-ply creped tissue paper.

2,631,847. Web accumulator. Clarence L. Hornberger, assignor to Armstrong Cork Co. Filed April 19, 1949. 5 claims. (Cl. 271-2.2.) A web accumulator for floor and wall coverings.

2,631,851. Vibratory feeder for carton flats and the like. Wickliffe Jones, assignor to The R. A. Jones and Co. Filed July 27, 1950. 9 claims. (Cl. 271-62.) Feeder rack vibrated at high speed by an electromagnet energized by electric current.

2,631,868. Carbon paper pack for manifolding typewriters. Joseph C. Doyle, assignor to Kee Lox Manufacturing Co. Filed Feb. 16, 1951. 1 claim. (Cl. 282-1.) The carbon sheets, in a paper wrapper, are stitched at one end to a backing sheet; both wrapper and carbon pack can be detachably secured to the supporting bar of the typewriter.

2,631,918. Color forming chemical reaction recorder. Walter F. Kozak, assignor to General Electric Co. Filed June 14, 1951. 5 claims. (Cl. 346-111.) A recording apparatus with a stylus of sodium lead or sodium amalgam and white recording chart paper impregnated or coated with wax and then sprayed with a solution of phenolphthalein.

2,631,922. Process of producing noncolloidal calcium carbonate. Milton O. Schur and Robert M. Levy, assignors to Ecusta Paper Corp. Filed Aug. 3, 1949. 2 claims. (Cl. 23-66.) Process for producing calcium carbonate suited for use as a filler in cigarette paper.

2,631,943. Process for the manufacture of a pulverulent alkyl cellulose coated upon a pulverulent carrier. Max Matter, assignor to Ciba Ltd. Filed Aug. 13, 1948. 3 claims. (Cl. 106-193.)

2,631,946. Process for making asphalt impregnated floor covering. Fred C. Schueler, assignor to The Schueler Engineering Co. Filed Sept. 16, 1948. 6 claims. (Cl. 117-45.) A moving felted web of vegetable, synthetic, or animal fibers covered with a decorative thermosetting plastic on one side, subjected to heat, and subsequently treated on the uncoated side with a controlled amount of asphalt.

2,631,960. Method of surfacing wood and similar materials with copolymerizable mixtures. Edwin H. Dafter, Jr., assignor to American Cyanamid Co. Filed March 21, 1951. 12 claims. (Cl. 154-121.) A method of surfacing pressed board or plywood with a solid copolymer.

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R23,637. Method of coating paper. William J. Montgomery, assignor to The Champion Paper and Fibre Co. Original No. 2,568,288, dated Sept. 18, 1951. Application for reissue April 9, 1952. 32 claims. (Cl. 117-64.) Process for the continuous production of a uniformly high-quality, cast-surfaced, coated paper.

2,632,366. Web-treating fibrous matters. Sten E. E. Ahlfors. Filed July 8, 1946. 3 claims. (Cl. 92-33.) Liquid suspensions of fibers can be strained, classified, dewatered, and washed by an apparatus comprising an upper vat with a strainer bottom and a second vat below connected by a flexible diaphragm.

2,632,481. Snow fencing. George L. R. Longtin, assignor to

Kraft Paper Products, Ltd. Filed March 10, 1950. 2 claims. (Cl. 139-425.)

2,632,563. Container. Willard C. MacIntyre. Filed June 16, 1950. 10 claims. (Cl. 206-45.32.) A cylindrical container with a cellophane to cover for packaging pies.

2,632,564. Shirt package and method of packaging. Samuel M. Bloom. Filed May 7, 1951. 9 claims. (Cl. 206-46.) A thin cardboard sheet on which the shirt is folded and an opaque bag with a window through which identification marks may be read.

2,632,593. Multiple carton structure. Ernest J. Minster, Jr., and William S. Schott, assignors to Fort Pitt Brewing Co. Filed March 31, 1950. 1 claim. (Cl. 229-15.) A double fiberboard carbon for beverage bottles or cans.

2,632,594. Egg case. Henry M. Nelson. Filed May 25, 1951. 11 claims. (Cl. 229-27.) Corrugated or fiberboard double-compartment egg case made from a single blank with compartments formed by multifolded extension panels.

2,632,595. Basket. Burl E. Finkbone, assignor to The Fairfield Paper and Container Co. Filed Oct. 22, 1949. 3 claims. (Cl. 229-52.) A fiberboard, paperboard, or corrugated board container and handle for use as a produce basket.

2,632,607. Winding machine. Paul R. Heygel, assignor to Ecusta Paper Corp. Filed Sept. 9, 1947. 5 claims. (Cl. 242-65.) A machine for the fast and safe rewinding of narrow-width bobbins of cigarette paper.

2,632,642. Guide for moving webs or sheets. Lynn F. Cooper, assignor to Gilbert & Nash Co. Filed April 6, 1949. 12 claims. (Cl. 271-2.6.) A sensitive wire guide for laterally moving webs of paper, regenerated cellulose, felt, etc.

2,632,699. Manufacture of high wet strength paper. William F. Fowler, Jr., and Donald R. Spear, assignor to Eastman Kodak Co. Filed June 17, 1950. 9 claims. (Cl. 92-3.) Method of preparing a photographic paper of good size resistance, high wet strength, and good resistance to ultraviolet light.

2,632,703. Light sensitive diazotype materials containing tetrazo diphenyl compounds. Sam C. Slifkin, assignor to General Aniline & Film Co. Filed Dec. 30, 1948. 7 claims. (Cl. 95-7.)

2,632,714. Process for coating paper web. Joseph T. Loomer, assignor to Robert Gair Co., Inc. Filed April 4, 1950. 6 claims. (Cl. 117-60.) Web is coated with an aldehyde (glyoxal) and a mineral pigment with a protein adhesive.

2,632,723. Wrapper for hams. Clarence G. Bennett, assignor to Paterson Pacific Parchment Co. Filed May 15, 1950. 2 claims. (Cl. 154-50.) A three layer wrapping paper for ham, bacon, etc., comprising an inner greaseproof sheet, an intermediate absorbent sheet, and an outer wrapper sheet suitable for printing.

2,632,741. Fire-resistant coating composition. Lewis W. Eckert, assignor to Armstrong Cork Co. Filed Jan. 19, 1952. 8 claims. (Cl. 260-17.3.) Fire-resistant coating for fiberboard.

2,632,742. Fire-resistant coating composition and method of making the same. Lewis W. Eckert, assignor to Armstrong Cork Co. Filed Jan. 19, 1952. 16 claims. (Cl. 260-17.3.)

2,632,743. Fire-resistant coating composition for fiberboard and the like. Lewis W. Eckert, assignor to Armstrong Cork Co. Filed Jan. 19, 1952. 9 claims. (Cl. 260-17.3.)

2,632,744. Preparation of polymerized polyester resin materials of improved strength and water resistance. Arthur M. Howald, assignor to Libbey-Owens-Ford Glass Co. Filed Jan. 31, 1947. 10 claims. (Cl. 260-17.3.)

March 31, 1953

2,632,918. Method and means for the end coating of packages. Samuel Bergstein. Filed June 8, 1949. 23 claims. (Cl. 18-1.) Further improvements to Patent No. 2,548,251, dated April 10, 1951.

2,632,945. Carton cutter. Park L. Newbold. Filed June 1, 1948. 3 claims. (Cl. 30-2.) A carton cutter designed specifically to open cigarette cartons for the purpose of stamping the individual packages.

2,633,062. Method of removing water from fibrous masses. Jack E. Gaston, assignor to Armstrong Cork Co. Filed Sept. 30, 1947. 6 claims. (Cl. 92-54.) Method of draining substantial amounts of water prior to oven drying of formed and compressed insulation blocks by tilting them at an angle of 15–90° from the horizontal.

2,633,063. Gluing machine. Rudolph E. Ohrn, assignor to Container Corporation of America. Filed March 19, 1951. 9 claims. (Cl. 93-36.4.) A compact, open-head gluing machine and a method for gluing.

2,633,064. Container making machine. Michel Welstein. Filed Dec. 8, 1949. 21 claims. (Cl. 93-44.) Closely guided, unattached mandrels move in a vertical path to form rectangular five-sided or tray-shaped boxes from cardboard sheet stock.

2,633,195. Clamp for paper-cutting machines. William C. Rupp, assignor to The Chandler & Price Co. Filed Nov. 16, 1948. 7 claims. (Cl. 164-51.) An automatic, vertically reciprocable clamp for holding a stack of papers in place on a power-driven paper cutter.

2,633,196. Straightedge and paper cutter. Harry Taran. Filed May 9, 1950. 4 claims. (Cl. 164-73.) A wallpaper cutter slidably mounted on a straightedge has a removable razor blade so positioned that either end of the cutting edge can be used.

2,633,219. Brake mechanism for paper-cutting machine and the like. William C. Rupp, assignor to The Chandler & Price Co. Filed Aug. 27, 1949. 17 claims. (Cl. 192-144.) A disk-type brake for securing and locking the knife of a power-driven paper cutter.

2,633,238. Container for fruits and vegetables. James E. Snyder, assignor to Wingfoot Corp. Filed Dec. 31, 1949. 1 claim. (Cl. 206-45.33.) A rectangular container with a bottom and two or three boxboard sides and the top and remaining sides of a transparent film.

2,633,275. Shirt board. Harry A. Tomarin, assignor to Loroco Industries, Inc. Filed Oct. 24, 1951. 6 claims. (Cl. 223-71.) A one-piece cardboard shirt board.

2,633,280. Bag packaging method and machine. Frank H. Davies, assignor to The Great Western Sugar Co. Filed Dec. 17, 1945. 25 claims. (Cl. 226-14.) The machine automatically fills paper bags with sugar, squares each bag, and places it in a bale.

2,633,284. Sealed cooking container for comestibles. Howard. J. Moffett and John C. McFarland. Filed March 28, 1949. 2 claims. (Cl. 229-2.5.) Frozen foods (particularly meats) packaged in panlike aluminum foil wrappers can be cooked and served in the foil.

2,633,285. Partitioned container with closure. Benjamin F. Kells, assignor to Container Corporation of America. Filed Nov. 12, 1949. 3 claims. (Cl. 229-15.) A rectangular corrugated paperboard container with securable cover for shipping baby chicks.

2,633,286. Cover and its manufacture. Robert A. Claridge and Leonard C. Thomas, assignors to Bemis Bro. Bag Co. Filed March 7, 1950. 7 claims. (Cl. 229-53.) Kraft paper gusseted covers for furniture and similar large articles.

2,633,287. Shopping bag and package display carrier. Edward G. Jacobsson. Filed Sept. 20, 1948. 7 claims. (Cl. 229-54.) Multiple-compartment heavy paper bags form a combined shopping bag and display-carrier assembly.

2,633,421. Fiber liberation by steam expansion. Robert S. Chapman and Byron B. Seibenhaar. (Chapman's interest assigned to Elmer R. Perkins and Harry Miner.) Filed Oct. 23, 1947. 3 claims. (Cl. 92-1.) Fibers (e.g., ramie) are extracted by alternate application and rapid release of steam pressure.

2,633,430. Method of making stretchable unified paper. Waldo Kellgren and John W. Marschall, assignors to Minnesota Mining & Manufacturing Co. Filed April 26, 1950. 4 claims. (Cl. 117-60.) A method for making a unified paper for use in adhesive-masking tapes and pressure-sensitive tapes that have a stretch value of at least 10%.

2,633,431. Magnetic recording tape and method of making same. Oscar J. DeSylva, assignor to Shellmar Products Corp. Filed Dec. 20, 1947. 5 claims. (Cl. 117-64.)

2,633,432. Heat-sealable label stock. Harold J. Kenneway, Jr., assignor to McLaurin-Jones Co. Filed Sept. 29, 1949. 5 claims. (Cl. 117-76.) A heat-sealable label stock comprising a backing sheet with a two-layer coating: coating consists of a resinous adhesive layer and a plasticizer which do not merge until heated.

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TAPPI STANDARDS

Testing Methods, Specifications, and Recommended Practices

Fiber Analysis of Paper and Paperboard

Revision of TAPPI Tentative Standard T 401 m-42

THIS STANDARD IS UNDER THE JURISDICTION OF THE MICROSCOPY COMMITTEE

This method relates to the identification of the kinds of fibers present in a sample of paper or paperboard and their quantitative estimation. For accurate results considerable training and experience are necessary. The analyst should make frequent use of standard samples of known composition or of authentic fiber samples and should become thoroughly familiar with the appearance of the different fibers and their behavior when treated with the various stains. A knowledge of morphological characteristics of the different fibers is helpful and, in some cases, essential for their identification. Some information on this subject is given in Appendix A.

APPARATUS AND MATERIALS

1. *Microscope.* A compound microscope, preferably equipped with a mechanical stage and Abbé condenser. A magnification of 70 to 100 diameters is recommended for observation of fiber colors, although a higher magnification may be desirable for studying morphological characteristics. If an apochromatic objective is used, it is desirable to have a compensating eyepiece and an achromatic condenser.

The eyepiece shall have a cross hair, pointer, or dot for counting the fibers passing under it. Such an eyepiece can be supplied by the manufacturers, or it may be prepared by the technician, provided the point is placed in position at the field diaphragm in the eyepiece so as to obtain its image in focus.

2. *Slides and Cover Glasses.* Standard slides (1 by 3 inches) of clear, colorless glass and No. 2 cover glasses (22 mm. square).

3. *Dropper.* A glass tube about 10 cm. long and 8 mm. internal diameter, with one end carefully smoothed, but not restricted, and the other end fitted with a rubber bulb. The tube shall be graduated to deliver 0.5 ml.

4. *Warm Plate.* A plate with a plane, level top made of solid metal having a black mat finish, and provided with a control to keep the temperature of the surface between 50 and 60°C. (*1*).

5. *Dissecting Needles.* Two needles mounted in suitable handles. Steel needles may be used but are subject to corrosion by some of the stains used. Needles made from an alloy of platinum and iridium are preferred.

6. *Glass-Marking Equipment.* Either a glass-marking pencil or an aluminum stearate solution (*see* Appendix G) for marking lines on the slide.

7. *Light Source.* A 15-watt "daylight" fluorescent tube or equivalent daylight source.

8. *Camel's Hair Brush.* Small.

9. *Water.* Whenever water is mentioned in this method, distilled water is meant.

TEST SPECIMEN

When possible, the test specimen shall consist of approximately 0.2 gram of paper or paperboard torn from different portions of the test sample so as to be representative of it.

DISINTEGRATION OF SAMPLE

1. Ordinary Papers

(a) Tear the sample into small pieces and place in a small beaker. Cover with water, bring to a boil on a hot plate, decant the water, roll the individual pieces into small pellets between the fingers, and place in a large test tube. Add a little water and shake vigorously until the water is thoroughly absorbed by the paper. Add a little more water, shake well, and again add some water and shake. Continue in this way until the paper has been thoroughly disintegrated. After the paper has been completely defibered, dilute the suspension by discarding part of it and adding water to the remainder until the suspension has a final consistency of about 0.05%. If the sample is difficult to disintegrate, glass beads may be used in the test tube, but if this is done, it should be so stated in the report. Glass beads should not be used if the fibers are to be examined for degree of beating.

(b) If the paper cannot be disintegrated by shaking in water, return the specimen to the beaker and cover it with 1% NaOH solution, bring to a boil, decant the alkaline solution, and wash twice with water. Cover the specimen with approximately 0.05 *N* HCl, let stand several minutes, decant the acid, and wash several times with water. Roll into pellets and proceed as in method (a).

Note: If it is known that the specimen will not disintegrate by method (a), the analyst may start with method (b). Roofing

This revision has been approved by the Standards Committee. Criticisms are earnestly requested and should be sent to R. G. Macdonald, Secretary, Technical Association of the Pulp and Paper Industry, 155 E. 44th St., New York, N. Y.

papers and papers containing wool fibers, however, must not be so treated, since the alkali may dissolve the wool.

(c) If the specimen cannot be disintegrated by either method (a) or (b), use one of the special methods given below.

2. *Specially Treated Papers*

Standardized methods cannot be specified for the disintegration of papers containing tar, asphalt, rubber, viscose, etc., or parchment papers, because the procedure needs to be varied according to the material, the amount present, and the nature of the treatment. The following methods are given as guides.

(a) Tar and Asphalt-Treated Papers

Method 1. Place the sample in a dish, cover with heavy coal-tar oil and digest on a steam bath for 1 hour. After this, remove and press the sample between blotters; cover with medium heavy coal-tar oil, treat it again on the steam bath and again press between blotters. Then extract with cold benzene until the solution is clear. No NaOH should be used in the final disintegration of these papers because of the possible presence of wool fibers (*2*).

Method 2. Fill several convenient containers (250-ml. beakers) about half full with carbon tetrachloride (CCl_4). Cut the sample into convenient squares and immerse in the first container. The squares should be moved about and the liquid kept agitated. After several minutes in the first container, transfer the squares to the next container, using forceps. Do not allow the squares to dry. In the case of laminated papers, the sheets may be separated easily after the first or second soaking and this should be done, removing any scrim or mesh, which can then be treated separately, if desired. Continue moving the sample into fresh CCl_4 until the liquid remains clear after the sample has been agitated in it for several minutes, then remove the sample and allow to air dry. After drying, disintegrate the sample in the usual manner.

(b) Rubber-Treated Papers

Extract the paper for 6 hours in a Soxhlet extractor with cumene (isopropyl benzene,) dry, and then boil in water to which a little wetting agent has been added. In very rare cases, a 1% NaOH solution may be necessary. With most samples, the cumene will take out about 98% of the rubber (*3*).

(c) Parchment Papers

Method 1. To 25 ml. of water, added 25 ml. of cond. H_2SO_4 and cool to 50 to 60°C. Place the paper in the acid and when the paper begins to disintegrate, stir quickly and empty into a 1-liter beaker two-thirds full of water (*4*).

Method 2. Soak the sample for about 5 minutes in conc. HCl, wash, boil up in 0.5% NaOH solution, and repeat this sequence if necessary. Then wash, acidify with dilute HCl, again wash, and then boil in a little water and a suitable wetting agent, and disintegrate (*4*).

(d) Pyroxylin-Treated Papers

Extract or remove the pyroxylin with cellosolve (ethyleneglycol monoethyl ether), ethyl acetate, or amyl acetate (*3*).

(e) Wet-Strength Papers

Method 1. Tear the paper into small pieces and place in a beaker; cover with 5% aluminum sulphate solution and boil from 5 to 20 minutes, depending upon the amount of wet strength present. Decant the alum solution, wash, and proceed as in section 1 (b), for Ordinary Papers.

Method 2. When an estimation of the degree of beating of the fibers is not required, the sample may be disintegrated in water in a Waring blendor. However, this method should never be used on samples that are to be examined for degree of refining.

(f) Highly Colored Papers

If the paper is highly colored, remove the dye by one of the following methods and then disintegrate by the usual procedure. (The treatment selected should be used with judgment and some knowledge of the characteristics of the dyes.) (1) By solution: Use alcohol, NH_4OH, acetic acid, or HCl. (2) By oxidation: Use nitric acid or bleach liquor. (3) By reduction: Use hydrosulphite, stannous chloride, or HCl and zinc (*2*).

PREPARATION OF SLIDES

It is desirable to keep the slides and cover glasses in 50% alcohol. After a slide has been dried and polished, draw lines 1 inch from each end, using the glass-marking pencil or aluminum stearate solution. This will keep the fiber suspensions inside the 1-inch square at each end of the slide. Remove any dust or lint from the slide with a small camel's hair brush. Place the slide on the warm plate, shake the test tube containing the defibered specimen, and withdraw a portion of the fibers by inserting the dropper and expelling two or three bubbles of air. Deposit 0.5 ml. of the fiber suspension on the square on one end of the slide. Withdraw another 0.5-ml. portion from the test tube and deposit it on the other end of the slide. Allow the water on the slide to evaporate until there is just sufficient left to float the fibers, then gently tap the suspension with a dissecting needle to distribute the fibers evenly inside the square. Leave the slides on the warm plate until completely dry (*1*).

STAINS

The Graff "C" stain is suggested as a preliminary over-all stain, but when desirable, other stains should be used for specific purposes or to confirm results obtained with the "C" stain. Thus, the Herzberg stain is especially useful to differentiate between rag, groundwood, and chemical wood pulps. Either Selleger's stain or Alexander's stain may be used to differentiate between coniferous and deciduous wood pulp and Selleger's stain is also helpful in differentiating between bleached coniferous sulphite and bleached coniferous sulphate. Wilson's stain may be used in place of, or to confirm results with, the "C" stain.

Morphological characteristics identify special fibers such as straw, flax, esparto, and certain types of wood, such as southern pine, western hemlock, and deciduous woods, so that the correct weight factors may be applied.

Directions for the preparation of the above stains are given in Appendix D, and the directions for the prepa-

ration and use of some special stains are given in Appendices E and F.

STAINING

When using the "C" stain, Herzberg stain, Selleger's stain, or Wilson's stain, apply 3 drops of the stain to the fiber field on the slide, then place a cover glass over it in such a way as to avoid air bubbles. Allow the slide to stand for 1 or 2 minutes, then drain off the surplus stain, preferably by tilting the long edge of the slide into contact with a blotter.

Note: Take care that the unstained fibers on the slide are not touched with the fingers, since the fingers usually have various metallic salts on them which will be absorbed and later may give rise to puzzling stain reactions.

The colors developed by the stain vary according to the raw materials and the process used for reducing them to pulp. The following discussion gives the colors to be expected, but the analyst should check known samples to become familiar with precise color reactions.

"C" Stain (1)

When lignin is present, a yellow color is developed with the "C" stain. Groundwood gives a very vivid yellow with a tendency toward orange; unbleached jute stains much the same color, but the two fibers can easily be distinguished by their structural appearance. Unbleached pulps of all kinds tend toward the yellow, with the depth of yellow determined by the degree of cooking and the type of cook. Thus, a raw unbleached sulphite will stain a vivid yellow, but as the degree of cooking increases, it tends toward a greenish yellow. Unbleached sulphate tends toward yellowish brown, while an unbleached alpha is more brown than yellow. The deciduous pulps have a tendency to appear bluish and greenish even in their unbleached state. Manila, straw, bamboo, sugar cane, flax hurds, and esparto also give yellow colors with raw, unbleached cooks.

When any pulp is bleached, it has a tendency to give a reddish hue with the "C" stain. In some cases this tendency is very slight, but any hint of red can generally be taken as an indication of some degree of bleaching. The shade of red usually indicates the type of bleached pulp. Thus, rag, which is the purest form of cellulose, gives the purest red, followed by bleached coniferous alpha, bleached coniferous sulphite, and bleached coniferous sulphate in that order. The sulphite is weak enough in red so that it frequently appears purplish-gray. Alkali cooking tends to give a bluish color to wood pulp, so that with bleached coniferous kraft pulp the blue coloration nearly overshadows the red and a bluish-gray is seen. Deciduous pulps have a tendency to be bluer than coniferous pulps; therefore, deciduous alkaline pulps, even though bleached, show almost no red when stained. Unbleached deciduous alkaline pulps cannot be easily distinguished from the bleached pulps, nor can deciduous kraft pulp be distinguished from deciduous soda pulp.

Some special fibers lend their own colors to the system. Thus, manila in the bleached state has a tendency toward purplish gray; bleached jute is a light yellow green; straw, bamboo, sugar cane, flax hurds, and esparto tend toward bluish gray, and sometimes give colors like deciduous alkaline pulps. In these cases, the pulps must be distinguished by their structural appearance. A color chart showing the colors obtained with "C" stain has been published by Graff (*17*).

Herzberg Stain (2)

Being an iodine stain, the general color trends discussed under "C" stain will hold also for the Herzberg stain. However, in general, it gives much bluer colors than the "C" stain, so that all chemical wood pulps, whether bleached or unbleached, acquire a blue tint. Rag pulp stains pink and can be easily distinguished from chemical wood pulps. Groundwood is a vivid yellow and easily distinguished. Unbleached jute and raw cooks of manila, straw, bamboo, sugar cane, flax hurds, and esparto also give a yellowish coloration; however, except for jute and manila, their bleached pulps stain blue, as do chemical wood pulps. Bleached jute gives a strong greenish yellow color. Manila varies from purple to pink. The raw, unbleached wood pulps will also tend toward greenish yellow if enough lignin is present.

The chief value in the Herzberg stain is the fact that all chemical pulps from wood and most grasses stain blue; therefore, a much sharper distinction is made between rag, groundwood, and chemical pulps. If the only interest is in the percentage of rag or of groundwood, the counting is much easier with the Herzberg than with the "C" stain.

Selleger's Stain

Its reactions also follow the general pattern for iodine stains but, in general, it gives redder colors than either the "C" or the Herzberg stain. Lignin-containing pulps, such as groundwood and unbleached coniferous wood pulp, give yellow colors. The depth of the yellow again depends upon the amount of lignin present. Esparto, straw, and alkaline-cooked deciduous woods give a purple or blue coloration which is easily distinguished from the colors given by other pulps.

Coniferous alkaline pulps give a much lighter blue, but these pulps can usually be differentiated from the coniferous sulphite pulps which tend more to the pink. Rag pulp will stain a little redder than bleached sulphite. Bleached manila and hemp give a wine red. Generally, no attempt is made to differentiate rag with Selleger's stain, but if rag is present, it is counted along with the bleached sulphite, and a correction is made based on the rag determination using Herzberg stain.

Wilson's Stain (14)

In an effort to obtain more distinctive colors with less overlapping, the commonly used potassium iodide is replaced in this stain with cadmium iodide and the hydroscopic zinc chloride is eliminated. In general, the colors obtained from the Wilson stain are similar to those of the "C" stain. A list of the colors obtained is given in Appendix H.

Alexander's Stain

This is a modification of the Herzberg stain which is sometimes useful for differentiating bleached sulphite, bleached sulphate, and soda fibers. To use this stain, apply 2 drops of solution A and allow to remain for 1 minute, after which carefully blot off the excess dye and allow the sample to dry. Add 3 drops of solution B

and allow to remain 1 minute; then, thoroughly mix 1 drop of solution C with the solution on the slide. Apply a cover glass in the usual manner. Bleached sulphite stains red, bleached soda pulp stains blue, and bleached sulphate gives a bluish red.

QUALITATIVE IDENTIFICATION

For the proper differentiation of the colors in fiber analysis, and also to become accustomed to the colors developed, it is recommended that a daylight fluorescent lamp be used at all times, preferably with the light tube placed 10 to 12 inches from the mirror of the microscope (*5*).

Place the stained slide under the microscope, center the light properly, and examine for the different fiber constituents present in the mixture, paying attention to morphological characteristics. In cases of doubt, make slides of authentic pulps for comparison with the sample.

QUANTITATIVE DETERMINATION

Bring the fiber field into focus and, with the mechanical stage, center it at a point 2 or 3 mm. from one of the corners of the cover glass. Move the stage gradually so that the observed field moves across the slide. Count the fibers of each kind as they pass under the center of the cross hairs or the end of the pointer. It is best to use a tally counter of the multiple type for this purpose, so that all the different types of fibers can be counted at one time. However, if care is exercised and the slide is not moved vertically, separate passes can be made for each type of fiber counted.

If a fiber passes the center of the cross hairs more than once, count it each time; but if part of the fiber follows the center for some time, count it only as one. With fiber bundles, as are often present in groundwood, count every fiber in the bundle as it passes under the center. Ignore very fine fragments, but count the larger fragments as fractions so that when two or three of the same kind of fiber fractions are observed in the same field, they can be mentally added together to give a whole number.

When every fiber in a line has been counted, move the stage 5 mm. vertically to a new line and count the fibers in the same manner. Continue this operation until the fibers in four separate lines across the slide, each 5 mm. apart, have been examined. If the slide has been properly prepared, this will give a total fiber count of between 200 and 300.

Multiply the total number of each kind of fiber by its respective weight factor (Table I) to obtain the equivalent weights, and calculate their percentages by weight of the total fiber composition.

Examine both square-inch fields. If the results for the two fields vary for any type of fiber present by more than the amount stated later under "Precision," then prepare and examine one or more additional fields and include the results from all the fields in the reported average.

WEIGHT FACTORS

Most of the weight factors given in Table I were determined by Graff (*6*) for the species of pulp wood commonly used at that time for making these grades of pulp. To some extent they depend on the size of the elements included in the count; consequently, each analyst should determine his own values for each kind of pulp he is likely to encounter. Weight factors depend more upon species than on type of cooking and will vary considerably with the different species. This is particularly important in hardwoods, where the weight factors have been found to vary from as low as 0.40 for maple to as high as 1.00 for gum. Likewise, a variation between 0.95 and 2.00 has been reported for cotton linters, depending on the source of the linter and the degree of beating (*15*). Therefore, the table should be used only as a guide when no better factors are available. Whenever possible, factors should be determined for the actual pulps used in the sample being analyzed. When this is impossible, the width of the fibers can be used by an experienced analyst as a guide in determining the correct weight factor to use (*13*).

Table I. Weight Factors

Fibers	*Factors*
Rag	1.00
Cotton linters	1.25
Bleached flax and ramie	0.50
Coniferous fibers	
Unbleached and bleached sulphite and kraft (except western hemlock, Douglas-fir, and southern kraft)	0.90
Western hemlock	1.20
Douglas-fir	1.50
Southern kraft	1.55
Alpha (northern)	0.70
Deciduous fibers	
Soda, sulphate, or sulphite (except gum and alpha)	0.60
Gum	1.00
Alpha	0.55
Groundwood	1.30
Unbleached bagasse fibers as prepared for boards	0.90
Bleached and unbleached bagasse fibers as prepared for papers	0.80
Esparto	0.50
Manila and jute	0.55
Sisal	0.60
Straw for board	0.65
Bleached straw	0.35

REPORT

The proportions of the various fibers found shall be reported in terms of percentages by weight of the total fiber composition to the nearest whole number, followed by an expression of the accuracy of the given figure. Thus, if the calculated percentage was 22.8 and the analyst feels the accuracy is ±3% the report would read 23 ± 3%. Percentages less than 2% shall be reported as "traces." In case of dispute, include the weight factors used.

PRECISION

The precision depends upon the skill and experience of the operator and on the selection of proper weight factors. Competent workers are expected to be able to check the composition of a furnish that is not too complex within the following tolerances:

Percentage of given fiber in total furnish	*Tolerance*
Less than 20	±2
20 to 30	±3
30 to 40	±4
40 to 60	±5
60 to 70	±4
70 to 80	±3
Over 80	±2

It is emphasized that to achieve this precision, authentic pulp mixtures should be examined from time to time to insure that sound judgment is exercised when including or rejecting debris in the count. Under ideal conditions with weight factors determined on the pulp being used, it is possible for experienced analysts to check the composition of a furnish within half the stated limits.

APPENDIX

A. Morphological Characteristics

Morphological characteristics are helpful in the identification of papermaking fibers but are subject to certain limitations because the action of swelling agents or modifications during refining may obscure the characteristics which typify related species (*7*). The characteristics of common pulpwood fibers are discussed in TAPPI Method T 8 sm, and those of other vegetable fibers in T 10 sm.

The cells in a pulp may be well separated or only imperfectly separated, depending on the type of pulping process used. In the groundwood or mechanical process, the pulp consists chiefly of torn fibers and fiber bundles. Occasionally, fiber bundles show undisturbed groups of wood ray cells at right angles to the longitudinal cells.

The most characteristic cells of *coniferous* or softwood pulps are the long, thin-walled springwood tracheids ("fibers") marked on their radial walls by one or more rows of large, irregularly spaced bordered pits and by areas of smaller pits. These large bordered pits allow for intercommunication between adjacent tracheids and the areas of smaller pits are contact regions with the cells of the radially oriented wood rays. Also present are the summerwood tracheids which have thicker walls, narrower cell cavities, and less pronounced pitting. The ray cells are relatively short, small, flat cells, with tiny pits. The broad springwood tracheids serve best if one wishes to study ray contact areas in an attempt to separate the various softwood pulp species.

Pulps from the *deciduous* trees or hardwoods normally exhibit greater diversity of cell types than do softwood pulps. The fibers (libriform fibers or fiber tracheids, as the case may be) are narrow, cylindrical cells with small, scattered pitting. These markings are not normally of value in species identification. It is necessary to locate and study the vessel segments, a cell type characteristic of the hardwoods, in order to identify the species. The vessel segments are considerably wider than the fibers and, because of their longitudinal linkage into long tubes or vessels, show openings or perforations at either end and pits of various sizes and shapes on the side walls. The details of pitting, perforation types, cell size, and shape serve to differentiate the various deciduous pulps. One must look carefully for vessel segments because in certain pulps the number may be reduced significantly during preparation of the pulp. The short, flat cells in the hardwood pulps are ray cells or longitudinal wood parenchyma cells.

Groundwood is characterized by the presence of bundles of fibers. Some of these fiber bundles show undisturbed groups of wood ray cells at right angles to the tracheids. The general shape and size of the torn fibers and bundles may be used as an index to show the character of the pulp produced. Groundwood is usually produced from nonresinous conifers, but deciduous woods are sometimes used.

As various weight factors are recommended for chemical pulps of certain species, the fiber analyst should endeavor to identify these pulps so that a more exact picture of the composition of any fibrous furnish may be reported. Douglas-fir is readily identified because all the springwood tracheids and nearly all its summerwood tracheids exhibit spiral thickening on the inner surface of the cell wall adjacent to the lumen or cell cavity. Tracheids from the various species of southern yellow pines can be separated with certainty from all American softwoods except jack, ponderosa, and lodgepole pines, because of the irregularly shaped and spaced ray-crossing pits, evident especially on the springwood fibers. Since there is a tendency toward greater diameter in the tracheids of the southern pines, one can often separate these species from the hard pines previously listed. The separation of western hemlock from other hemlocks, spruces, and larches is not easy and is at times impossible. The color differentiation of western sulphite pulp with the "C" stain and the tendency toward greater fiber width than the eastern species may be useful. The identification of the black gums and tupelos from other hardwoods except sweet gum (red gum) is accomplished by observing the presence of scalariform perforations containing a relatively large number of bars in the vessel segments. As the tips of sweet gum vessel segments have spiral thickening and the black gums do not, their separation is readily made. It is strongly recommended that sm T 8 as well as authentic pulp samples be consulted. If in doubt, one should use the general weight factor (0.60).

Jute and manila constitute the majority, but not all, of the "rope fibers" found in papermaking. It is sometimes essential to differentiate them. Manila fibers are usually longer and have a well-defined, quite uniform, uninterrupted central lumen which differentiates them from the jute fibers which have a variable central lumen, changing in the same fiber from broad to narrow and even being entirely interrupted at certain places. The cell walls of jute have longitudinal striations. Manila pulps sometimes have small cells (staining brown with Herzberg stain) which occur singly or in groups. These are so infrequent that they cannot be considered characteristic but do denote the presence of manila if they can be found. Manila and jute can sometimes, but not always, be differentiated by the observation that jute stains yellow and manila wine-red with the Herzberg stain. In the analysis of rope and paper, there are cases where it may be advisable to take special cognizance of the different colors developed by jute and manila, as these colors are indicative of the previous history of the fibers. Unbleached jute stains a strong yellow with Herzberg stain; jute that has been cooked moderately and then bleached gives a lighter yellow color; after drastic cooking and bleaching, the color is a steel blue or gray. Manila hemp may vary from dark blue to light red (not so deep as for rag), depending on the degree of cooking.

Rag pulp consists of cotton and linen fibers. As rags usually undergo considerable treatment, it is not always easy to distinguish the twists of cotton and the nodes of

linen. They are not usually reported separately, being grouped under the general designation of "rag." Pulp produced from cotton linters is also reported as rag. This pulp is composed of a mixture of lint fibers which are similar to rag and the true linter fibers which are shorter and coarser than the lint fibers. The linters are more nearly cylindrical than lint cotton or rag fibers and have thicker walls and narrower central canals, and, therefore, a higher weight factor. At their distal ends they taper to a point. At their basal ends the fibers are either open as a result of breaking away from the seed coat during delinting, or they have the mother epidermal cell still attached to the fiber. Where the epidermal cell remains attached to the elongated fiber, the latter is found to be narrower than the epidermal cell of which it is an outgrowth, and to be separated from it by a constricted region (*16*). Some of the fibers show a decided twisted appearance at the base. The color of linters with Herzberg stain is red, although the red is darker and upon close examination, it seems that part of the pectocellulose has not been removed and tends to give a bluish tinge. This is especially true of the base which is always darker in color.

Esparto, the *straws*, *cornstalks*, and *bagasse* (sugar cane) contain the widest variety of cells. Esparto is encountered in some printing papers, especially those made in Great Britain; unbleached straw is met in many container boards, and bleached straw may occasionally occur in better grades of papers, particularly those of foreign origin. Cornstalk and bagasse occur mostly in fiberboard used for building purposes. The general class of grasses used for fiberboard is in need of systematic study in order to differentiate them. The majority of the cells found in these pulps are the fibers, which are fine, slender, and without distinctive structure. Serrated cells, pith cells (rings from annual vessels), and vessels are present in all these pulps. Most characteristics of esparto are "tear drops" or comma-shaped hairs or bristles, known as trichomes; but unless care is exercised, and especially if the pulp has been well washed, they may be overlooked.

Semichemical pulps are cooked by a variety of procedures and thus give various color reactions. Because of the high lignin content, all tend toward the yellow with the "C" stain or Wilson's stain. If the cook is alkaline, the tendency is toward the blue; while if the neutral sulphite cook has been used, the tendency is toward the red. Exact behavior of these pulps with the stains listed has not yet been established.

B. Synthetic Fibers

In view of the widespread use of artificial or synthetic fibers in textiles, these are often found in rags and occasionally get into finished paper. The reaction of these fibers, either before or after a conventional rag cook, has not yet been established, although it is known that the common iodine stains when used on uncooked fibers give blue colors only with the regenerated cellulose fibers such as viscose and Bemberg. All the other synthetics give various shades of yellow to reddish tan or do not stain at all, the colors obtained varying considerably with time of contact with the stain and with manufacturing variations in the fiber.

A comprehensive report on the characteristics of synthetic fibers has been prepared by a committee of the British Textile Institute (*11*) and schemes for their differentiations have been given by Houghton (*12*).

C. Wool

Varying amounts of wool are often found in building papers and somtimes in mulching papers. The fibers may be easily identified by the epidermal scales covering their surfaces. If undyed, they stain a pale yellow with zinc-iodine stains. Blaisdell and Minor (*10*) have suggested a weight factor of 2.0 for wool (basis, cotton = 1.0).

D. Preparation of Stains

1. "C" Stain

Prepared "C" stain can be purchased from The Institute of Paper Chemistry, or it may be prepared from the following solutions (*1*, *20*):

A. Aluminum chloride solution of 1.15 sp. gr. at 28°C., made by adding about 40 grams of C.P. $AlCl_3 \cdot 6H_2O$ to 100 ml. of water.

B. Calcium chloride solution of 1.36 sp. gr. at 28°C., made by adding about 100 grams of C.P. $CaCl_2$ to 150 ml. of water.

C. Zinc chloride solution of 1.80 sp. gr. at 28°C., made by adding approximately 25 ml. of water to 50 grams of dry $ZnCl_2$ (fused C.P. sticks in sealed bottles, or C.P. crystals). Do not use $ZnCl_2$ from a previously opened bottle.

D. Iodide-iodine solution, made by dissolving 0.90 gram of dry C.P. KI and 0.65 gram of dry C.P. iodine in 50 ml. of water. Dissolve the KI and iodine by first thoroughly intermixing and crushing together, then adding the required amount of water drop by drop with constant stirring.

Mix well together, 20 ml. of solution A, 10 ml. of solution B, and 10 ml. of solution C; add 12.5 ml. of solution D and again mix well. Pour into a tall, narrow vessel and place in the dark. After 12 to 24 hours, when the precipitate has settled, pipet off the clear portion of the solution into a dark bottle and add a leaf of iodine. Keep in the dark when not in use.

Note: The "C" stain is very sensitive to slight differences, and extreme caution must be exercised in its preparation and use. The solutions used for preparing all iodine stains should be of the exact specific gravity specified and accurately measured with graduated pipets. Dark-colored, glass-stoppered dropping bottles, preferably wrapped with black paper, should be used as containers. Fresh stain should be made every 2 or 3 months.

2. Herzberg Stain (*2*)

A. Zinc chloride solution of 1.80 sp. gr. at 28°C., made by adding approximately 25 ml. of water to 50 grams of dry $ZnCl_2$ (fused C.P. sticks in sealed bottles, or C.P. crystals).

B. Dissolve 0.25 gram of C.P. iodine and 5.25 grams of C.P. potassium iodide in 12.5 ml. of water.

Mix 25 ml. of solution A with the entire solution B. Pour into a narrow cylinder and let stand until clear (12 to 24 hours). Decant the supernatant liquid into an amber-colored, glass-stoppered bottle and add a leaf of iodine to the solution. Avoid undue exposure to light and air.

Note: For special tests, the Herzberg stain is sometimes modified by adding more $ZnCl_2$ to accentuate the blue, or more iodine to accentuate the red. However, modification is not recommended for normal use.

3. Selleger's Stain

Prepare by either of the following methods:

A. Dissolve 100 grams of calcium nitrate, $Ca(NO_3)_2 \cdot 4H_2O$, in 50 ml. of water. Add 3 ml. of a solution made by dissolving 8 grams of KI in 90 ml. of water. Finally, add 1 gram of iodine and let stand for 1 week. The stain is then ready for use.

B. Dissolve 0.267 gram of KI in 53 ml. of water; add 1 gram of iodine, and let stand for 2 weeks, shaking each day to saturate the solution with iodine. Then dissolve in this solution 100 grams of $Ca(NO_3)_2 \cdot 4H_2O$, and the stain is ready for use. (By saturating with iodine a solution containing 1 gram of KI to each 198 ml. of water, a saturated stock solution may be made to which it is only necessary to add $Ca(NO_3)_2 \cdot 4H_2O$ in the proportion of 100 grams to 53 ml. of the stock solution.)

If the stain does not give the colors desired (*see* Appendix G), it may be modified by adding more $Ca(NO_3)_2$ to make it bluer, or more KI to make it redder. A flake of iodine should be kept in the bottle at all times to maintain the proper iodine concentration.

4. Wilson's Stain (14)

Dissolve 1.5 grams of C.P. iodine and 70.0 grams of C.P. cadmium iodide in 100.0 ml. of water. Heat to 110°F. and break the iodine crystals with the end of a stirring rod. When all the solids are dissolved, add 180 ml. of water, 15 ml. of U.S.P. 37% formaldehyde, 140 grams of C.P. $Ca(NO_3)_2 \cdot 4H_2O$, and 40 grams of C.P. cadmium chloride ($CdCl_2 \cdot 2.5H_2O$).

Store the finished solution in an amber stock bottle. Titrate a portion of the stain with 0.01 *N* sodium thiosulphate (2.482 grams of $Na_2S_2O_3 \cdot 5H_2O$ per liter), adding starch indicator near the end point. Ten ml. of stain solution should be equivalent to 12.0 ± 2.0 ml. of 0.01 *N* thiosulphate solution.

If the stain is too strong, withdraw 100 ml. for use and heat at 110°F. until titration shows the proper strength. With freshly prepared stain, about 20 to 30 minutes heating is needed to give the proper concentration of iodine. Store the remaining stain in the concentrated form for future use. Check the stain solution in use from time to time by titration to determine whether the solution has become too weak and should be discarded.

5. Alexander's Stain

Prepare the following solutions:

A. Dissolve 0.2 gram of Congo Red dye in 300 ml. of water.

B. Dissolve 100 grams of $Ca(NO_3)_2 \cdot 4H_2O$ in 50 ml. of water.

C. Herzberg stain, as previously described.

E. Special Stains

6. Kantrowitz-Simmons Stain (Modified Bright Stain) (18)

Prepare the following solutions:

A. Dissolve 2.7 grams of ferric chloride, $FeCl_3 \cdot 5H_2O$, in 100 ml. of water.

B. Dissolve 3.29 grams of potassium ferricyanide, $K_3Fe(CN)_6$, in 100 ml. of water.

C. Dissolve 0.5 gram of benzopurpurin (Du Pont Purpurin 4B Conc. or its equivalent) in 100 ml. of 50% ethyl alcohol. Warm the solution until the dye is completely dissolved. (Some of the dye will precipitate on cooling.)

Keep solutions A and B in separate bottles. These solutions should be renewed frequently. Solution C may be used indefinitely. When the solution becomes cloudy, warm until it becomes clear again.

This stain either may be applied to fibers on the slide, or 1.5 grams of the fibers may be stained in 50 ml. of the solution in a beaker. In either case, mix equal parts of solutions A and B just before using; apply for 1 minute at room temperature, thoroughly wash the stain mixture from the fibers, and then stain them for 2 minutes with solution C. After staining, again thoroughly wash the fibers before observation.

This stain indicates the amount of lignin present and is therefore affected both by the degree of bleaching and of cooking. A well cooked, well bleached pulp will stain red, while a poorly cooked, unbleached pulp will stain blue. All stages between will be found with different degrees of cooking and bleaching; the same pulp will frequently contain both red and blue fibers, or fibers in which one end stains red and one end stains blue. It is evident that care must be exercised in drawing conclusions from the use of this stain.

7. Lofton-Merritt Stain (19)

Prepare the following solutions:

A. Dissolve 2 grams of malachite green in 100 ml. of water.

B. Dissolve 1 gram of basic fuchsin in 100 ml. of water.

As in the case of the Kantrowitz-Simmons stain, the Lofton-Merritt stain may be applied either to the fibers on a slide or in a beaker. When staining in a beaker, add 1.5 grams of fibers to a mixture of 15 ml. of solution A, 20 ml. of solution B, and 0.09 ml. of conc. HCl. After 2 minutes at room temperature, pour the dye off the fibers and wash them. If the staining is done on the slide, add a mixture of the dyes first and after 2 minutes remove the excess dye by blotting with a hard filter paper. Add a few drops of 0.1% HCl and after 30 seconds remove the excess HCl by blotting. Finally, add a few drops of water and remove the excess with a cover glass.

This stain is affected also by the amount of lignin present. If the pulp is free of lignin, the fibers will be colorless; if the pulp is highly lignified, they will stain blue. All stages between will be found, depending upon the degree of delignification. Unbleached sulphite pulp has a tendency to give a redder color than unbleached kraft; therefore, this stain has some value for their differentiation. However, if any special treatment has been given to the pulps, this will interfere with the test, and hence it can be used only as an indication of the presence of unbleached kraft or unbleached sulphite, and not as a conclusive test.

F. Spot Stains for Groundwood

It is often desirable in the plant or laboratory to detect merely the presence or absence of groundwood. No microscopic examination is necessary; the stain is simply applied to the paper and the color observed.

Standards containing various percentages of ground-

wood and other pulps may be prepared and used as a basis of comparison for these spot stains.

Note: In using stains for application to the surface of paper, it is well to caution that many of the dyes used for colored papers are sensitive to acids and the color change, while apparently showing the presence of groundwood, may be caused by the action of the acid on the dyestuff. For colored papers, in case of doubt, it is well to run a blank test with a little dilute acid. Some types of safety check papers require particular care in this respect.

1. Phloroglucinol (8)

Dissolve 1 gram of phloroglucinol in a mixture of 50 ml. of methyl alcohol, 50 ml. of conc. HCl and 50 ml. of water. This formula gives a water-clear solution that turns yellowish slowly with age. If a stronger stain is desired, the water may be omitted. The life of the solution will be prolonged if it is protected from light.

This stain produces a bright red or magenta color with groundwood. The depth of color is an indication of the amount of groundwood present. A very light color, however, does not necessarily prove its presence, as partly cooked jute, partly cooked unbleached chemical pulp, and some other ligneous fibers are also slightly colored. In many cases, jute papers show a deep coloration with this stain. Especially in the case of strong papers, indication of groundwood should be confirmed microscopically.

2. Aniline Sulphate (9)

Dissolve 1 gram of aniline sulphate in 50 ml. of water and add a drop of conc. H_2SO_4. This produces a yellow color on papers containing a considerable percentage of groundwood. It is not quite so sensitive as phloroglucinol, but is easy to obtain and prepare and costs less.

G. Preparation of Aluminum Stearate Solution

(a) To 600 ml. of water, add 15 grams of shavings from a good grade of soap and stir until the soap is completely dissolved. To the solution add 10 grams of C.P. aluminum sulphate, $Al_2(SO_4)_3 \cdot 18H_2O$. A white precipitate of aluminum stearate immediately forms. Stir with a glass rod until the precipitate coagulates into a wax-like mass. With the stirring rod, lift out the precipitated aluminum stearate and place in a desiccator for 48 hours. Store in a well-stoppered bottle to be used as needed.

(b) To 50 ml. of benzene in a glass-stoppered bottle, add 0.7 gram of the desiccated aluminum stearate. Shake well each day until completely dissolved. This usually requires about 10 days. The solution is then ready for use.

Note: If after several weeks it should be found that the solution has lost some of its capacity as a water repellent, add a small piece of aluminum stearate to the solution. This will correct the condition within a few hours (*1*).

H. Color Chart for Iodine Stains

I. *"C" Stain*

Highly purified pulps (such as alpha) are characteristically kinky in appearance. The word *raw* refers to unbleached pulp, raw or very lightly cooked. *Unbleached* and *bleached* refer to medium and well cooked pulps.

A. Groundwood: *Vivid yellowish orange*

B. Coniferous pulps
   1. Sulphite
      (a) Raw: *Vivid yellow*
      (b) Medium cooked: *Light greenish yellow*
      (c) Well cooked: *Pinkish gray*
      (d) Bleached: *Light purplish gray to weak red purple*
   2. High alpha
      (a) Unbleached: *Very pale brown to brownish gray*
      (b) Bleached: *Moderate reddish orange to dusky red*
   3. Sulphate
      (a) Raw: *Weak greenish yellow*
      (b) Medium and well cooked: *Strong yellowish brown to moderate yellowish green and dark greenish gray*
      (c) Bleached: *Dark bluish gray to dusky purple*

C. Deciduous pulps
   1. Sulphite
      (a) Unbleached: *Pale yellow green*
      (b) Bleached: *Weak purplish blue to light purplish gray*
   2. High alpha
      (a) Bleached: *Moderate reddish orange to dusky red*
   3. Soda and sulphate
      (a) Unbleached: *Weak blue green to dusky blue green and dark reddish gray*
      (b) Bleached: *Dusky blue to dusky purple*

D. Rag: *Moderate reddish orange*

E. Manila
   1. Raw: *Light greenish yellow*
   2. Unbleached and bleached: *Yellowish gray to weak blue and medium purplish gray*

F. Jute
   1. Unbleached: *Vivid yellowish orange*
   Bleached: *Light yellow green*

G. Straw, bamboo, cane, flax hurds, and esparto
   1. Raw: *Light yellow to weak greenish yellow*
   2. Unbleached and bleached: *Light greenish gray to dark bluish gray and medium purplish gray*

H. Japanese fibers
   1. Gampi and mitsumata: *Light greenish yellow to light bluish green*
   2. Kozo: *Pinkish gray*

II. *Herzberg Stain*

A. Groundwood: *Brilliant yellow*

B. Coniferous chemical pulps
   1. Raw: *Light olive gray to olive gray*
   2. Unbleached: *Dark bluish gray to weak purplish blue*
   3. Bleached: *Dark purplish gray to dark reddish purple*

C. Deciduous chemical pulps
   1. Raw: *Weak olive to dusky blue green*
   2. Unbleached and bleached: *Dark purplish gray to deep reddish purple*

D. Rag: *Brilliant purplish pink to vivid red purple*

E. Manila
   1. Raw: *Moderate yellow*

2. Unbleached and bleached: *Dark purplish gray to moderate purplish pink*

F. Jute
1. Unbleached: *Moderate yellowish orange*
2. Bleached: *Strong greenish yellow*

G. Straw, bamboo, cane, flax hurds, and esparto
1. Raw: *Light yellow*
2. Unbleached and bleached: *Light bluish gray to pale purplish blue and strong purplish pink*

H. Japanese fibers
1. Gampi and mitsumata: *Light greenish yellow*
2. Kozo: *Pinkish gray*

III. *Selleger's Stain*

A. Groundwood: *Yellow*

B. Coniferous pulps
1. Sulphite
(a) Unbleached: *Yellow*
(b) Bleached: *Red*
2. High alpha
(a) Bleached: *Red*
3. Sulphate
(a) Unbleached: *Yellow*
(b) Bleached: *Blue gray*

C. Deciduous woods
1. Sulphite
(a) Bleached: *Bluish red*
2. Soda and sulphate
(a) Unbleached: *Blue*
(b) Bleached: *Blue*

D. Rag: *Red*

E. Manila
1. Bleached: *Claret red*

F. Straw and esparto
1. Bleached: *Blue*

IV. *Wilson's Stain*

A. Groundwood
1. Unbleached: *Bright yellow*
2. Bleached: *Greenish yellow*

B. Coniferous woods
1. Sulphite
(a) Raw cook: *Very pale yellow*
(b) Medium cook: *Colorless*
(c) Well cooked: *Very pale gray*
(d) Bleached sulphite: *Pinkish lavender*
2. Alpha
(a) Unbleached: *Orange red*
(b) Bleached: *Pale violet*
3. Sulphate
(a) Raw cook: *Dull brown*
(b) Medium and well cooked: *Gray*
(c) Bleached sulphate: *Blue; some blue with reddish spots*

C. Deciduous woods
1. Sulphite
(a) Raw cook: *Very pale yellow*
(b) Medium cook: *Colorless*
(c) Well cooked: *Very pale gray*
(d) Bleached: *Lavender*
2. Alpha
(a) Unbleached: *Greenish gray*
(b) Bleached: *Dark blue*
3. Soda
(a) Unbleached: *Bright purple*
(b) Bleached: *Pale purple*

D. Straw
1. Raw cook: *Green*
2. Well cooked: *Blue*
3. Bleached: *Dark blue*

E. Cotton: *Red*

F. Linen: *Pink*

ADDITIONAL INFORMATION

In the present revision, the method as previously revised in 1942 has been completely rewritten and rearranged. The fundamental principles have not been changed, but the technique has been refined and brought up to date. Five articles appearing since 1942 have been included in the Literature Cited. The Section on Morphological Characteristics (Appendix A) has been greatly enlarged. The weight factors for eight additional fibers have been added, and the factor for deciduous soda is changed from 0.50 to 0.60. The method of reporting results and the statement of precision expected have been changed.

The original Bright stain has been replaced by the modification proposed by Kantrowitz and Simmons; Wilson's stain has been added as an alternative or supplement for the "C" stain; and Alexander's stain and Selleger's stain have been added for differentiating between coniferous and deciduous pulp fibers. The Kantrowitz-Simmons stain and the Lofton-Merritt stain are now included in Appendix E. The method for preparing Herzberg stain has been changed.

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Needle Penetration of Petroleum Waxes*

TAPPI Suggested Method T 639 sm-53

(THIS SUGGESTED METHOD IS UNDER THE JURISDICTION OF THE WAX TESTING COMMITTEE)

THIS method describes a procedure for the empirical estimation of the consistency of waxes derived from petroleum by measurement of the extent of penetration of a standard needle. The sample is melted, heated to 30°F. above its melting point, and then cooled under controlled conditions to 77°F. The penetration is measured with a penetrometer by means of which a standard needle is applied to the sample for 5 seconds under a load of 100 grams.

DEFINITION

Penetration of petroleum wax is here defined as the depth, in tenths of a millimeter, to which a standard needle penetrates into the wax under defined conditions.

APPARATUS

1. *Penetrometer.* For applying the standard needle to the surface of the sample and for measuring the penetration at the conclusion of the test, the penetrometer shall be constructed in such a manner that, by means of a slow-motion adjustment of either the needle assembly or the table, depending upon the type of instrument, the accurate placement of the tip of the needle adjoining the level surface of the sample may be made while maintaining a zero reading on the indicator. It must be determined that the loaded needle falls, when released, without appreciable friction. An automatic timing release mechanism may be used. The instrument shall be provided with leveling screws and a spirit level to maintain the needle shaft in a true vertical position. A simplified sketch of such an instrument with needle attached is shown in Fig. 1.

Note: Figure 1 represents a composite drawing illustrating the two available types of instruments, that with an adjustable table, and that with an adjustable needle assembly. The use of either type instrument is permissible in this test.

2. *Needle.* Made from a cylindrical steel rod approximately 2 inches long and 1.00 mm. in diameter conforming to requirements given in Fig. 2. After tapering, the point shall be "blunted" by grinding off to a truncated cone. The finished needle shall be hardened and highly polished. The exposed length of the needle, when mounted in the chuck of the penetrometer or in a ferrule, shall be 41.5 ± 1.5 mm.

Note: The National Bureau of Standards will measure and certify the accuracy of penetration needles in accordance with the permissible variations given.

3. *Sample Container.* This shall consist of a brass cylinder open at both ends, having a 1-inch inside diameter, $1\frac{1}{4}$-inch height, and $\frac{1}{8}$-inch wall thickness. To prevent slippage of very hard wax, a few screw threads should be cut into the center part of the inside wall of the cylinder. The cylinder is to be placed on a base plate of brass or glass, wetted with a 50% solution of glycerine in water.

4. *Water Bath.* Capable of being maintained at 77 ± 0.2°F. The volume of water shall be not less than 10 liters. The sample shall be immersed in the bath to a depth of not less than 4 inches and shall be supported on a perforated shelf not less than 2 inches from the bottom of the bath. The bath shall be equipped with a circulating pump to supply the thermostat used during testing and maintain a uniform water temperature.

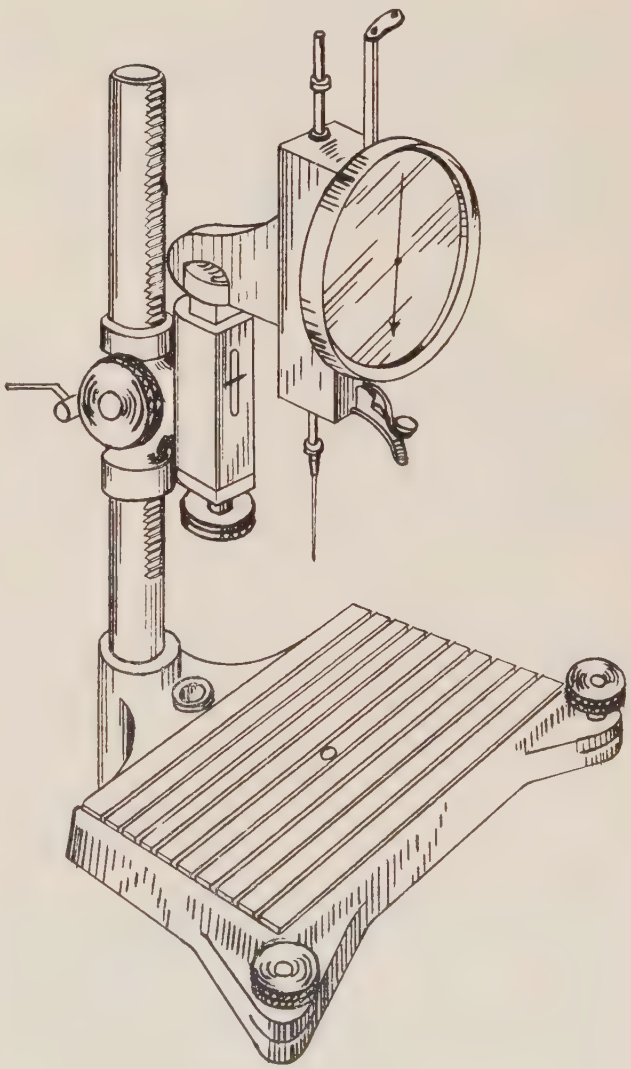

Fig. 1. Penetrometer

* This method is suggested by the Standards Committee as being the most suitable to date. It is *not*, however, a TAPPI Standard. Criticisms are earnestly requested and should be sent to R. G. Macdonald, Secretary, Technical Association of the Pulp and Paper Industry, 155 E. 44th St., New York 17, N. Y.

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Notes: (1) Alternatively, the use of a constant-temperature test room or an air cabinet instead of the water bath and thermostat is permitted. Likewise, a box made of transparent plastic may be used as a water bath and the test performed directly in the water bath instead of in the thermostat described below.

(2) The test temperature may be other than 77 °F. but should not be so high as to give a penetration value exceeding 50. If a temperature other than 77 °F. is used, the actual test temperature shall be given in the report.

5. *Thermostat.* This shall be a wooden box lined with copper, with a minimum inside diameter of 90 mm. and a minimum depth above the bottom of 55 mm. Water from the water bath shall be circulated through the thermostat so that its temperature is equal to that of the water bath. Provisions shall be made to allow lowering and raising of the water level.

6. *Bath Thermometer.* An ASTM Saybolt viscosity thermometer having a range of 66 to 80°F. and conforming to ASTM specification 17F is recommended. The thermometer should be immersed to the 70°F. mark.

PREPARATION OF SAMPLE

Heat the wax to 30°F. above its melting point, using care to prevent local overheating, and stir until it is homogenous and free from air bubbles; then pour into the sample container in such a way that a convex meniscus is formed. Allow the container to cool in an air bath at 77 ± 2°F. for 1 hour; then place it in the water bath and allow to remain for 1 hour.

PROCEDURE

Remove the sample from the water bath and slide the brass cylinder containing the sample off the brass plate; use the surface that contacted the plate for testing. Place the sample in the thermostat maintained at 77 ± 0.2°F. The water level in the thermostat should be such as to cover the sample completely.

Place the thermostat with sample upon the penetrometer table, making certain that it cannot teeter during testing. Keep the needle in the thermostat for at least 5 minutes before attaching it to the penetrometer. Place a 50-gram weight above the needle, making a total load of 100 grams for the needle and all attachments. Observe that the indicator on the scale is in the zero position. Lower the water level in the thermostat until the sample surface is no longer covered with water. Adjust either the indicator assembly or the table, depending upon the type of instrument, until the tip of the needle nearly touches the surface of the sample. Securely lock the movable assembly in this position.

Note: If a transparent thermostat box is used, the needle can be positioned without lowering the water level.

Then, by means of the slow-motion adjustment, bring the needle tip to just touch the surface of the sample, watching the shadow of the needle tip as an aid to accurate setting. Raise the water level in the thermostat until the sample is completely covered. After 5 minutes release the needle shaft and hold it free for 5 seconds, timing this interval with a stop watch registering to 0.1 second. Observe that the release mechanism does not drag on the shaft; then gently depress the indicator shaft until it is stopped by the needle shaft, and read the penetration from the indicator scale.

Note: If an automatic timing release mechanism is not used, the timing can be done conveniently by starting the watch before the beginning of the test, releasing the needle shaft as the second hand crosses a unit graduation of the watch, and engaging the shaft of the needle when the watch indicates exactly 5 seconds later.

Make four tests at points about equally spaced (not less than $^1/_2$ inch apart) on a circumference at least $^1/_8$ inch from the side of the container. Before each test, wipe the needle carefully toward its point with a clean, dry cloth to remove all adhering wax, and position the needle as described above.

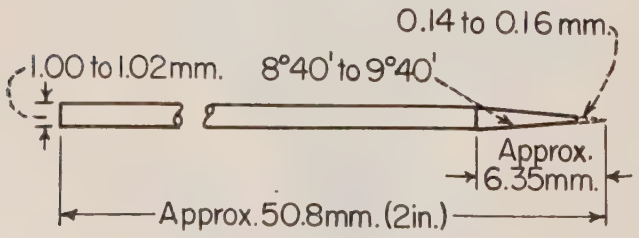

Fig. 2. Standard needle

REPORT

Report the average scale reading for the four (or more) tests as the needle penetration value, and include in the report the temperature at which the test was made.

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Plastics Conference, New York State College of Forestry, Syracuse, N. Y., September 15–16, 1953.

Testing Conference, Battelle Memorial Institute, Columbus, Ohio, September 21–23, 1953. (Wax Testing Committee and Paper Testing Committee.)

Tenth Fibrous Agricultural Residues Conference, Belleville, Ontario, October 8–9, 1953.

Third Corrugated Containers Conference, Statler Hotel, New York, N. Y., October 15–16, 1953.

Eighth Engineering Conference, Sheraton-Mt. Royal Hotel, Montreal, P. Q., October 26–29, 1953.

Seventh Alkaline Pulping Conference, Rice Hotel, Houston, Texas, November 18–20, 1953.

Thirty-ninth Annual Meeting, Commodore Hotel, New York, N. Y., February 15–18, 1954.

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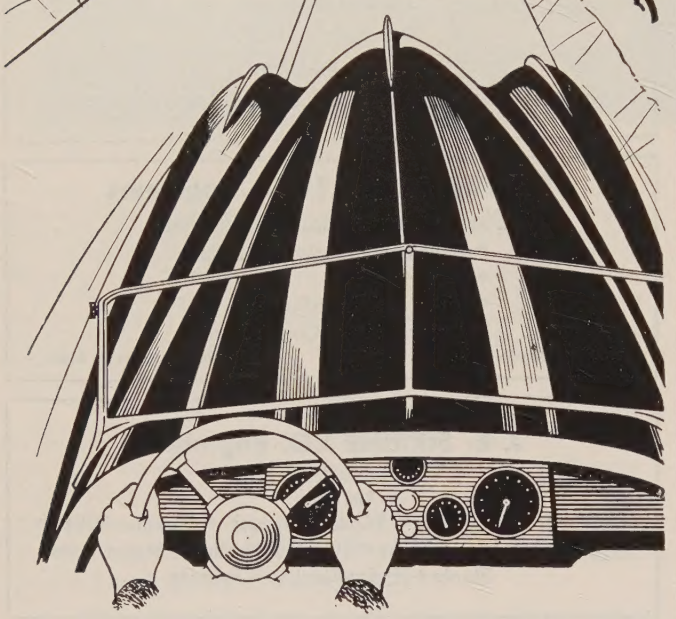

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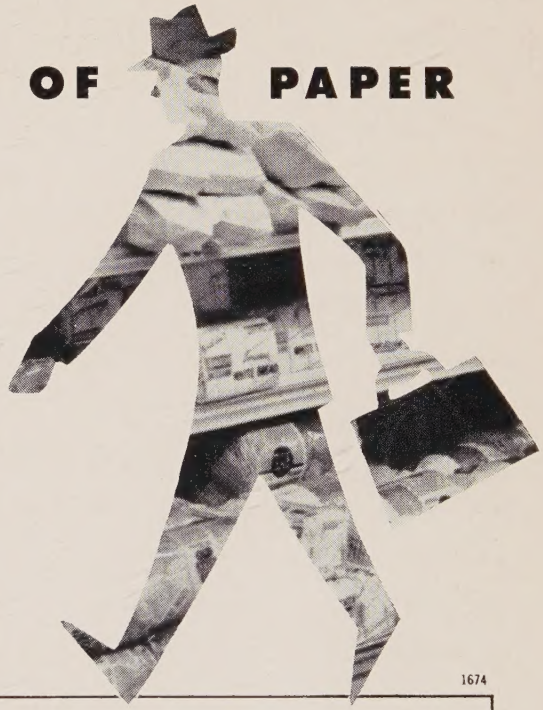

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